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Records and Descriptions of North American Crane-Flies (Diptera)¹

Part IX. The Tipuloidea of Oregon, I

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General Account

The state of Oregon is roughly rectangular in outline, its extreme east-west width being 380 miles, its greatest length, as measured along the 124th meridian 280 miles. It includes 96,699 square miles, of which 1092 are water. The state is bounded on the north by Washington and, in large part, by the Columbia River; on the east by Idaho, with the Snake River, a major tributary of the Columbia, forming more than one-half of this boundary; on the south it is bounded by the states of Nevada and California; on the west by the Pacific Ocean.

The Cascade Range divides the state into two unequal parts, the western third including the Willamette Valley and the Coast section, the eastern two-thirds the extensive but sparsely populated plains-plateau region. Physiographically, the state has been subdivided into eight more or less natural regions or provinces that are defined further on characters of climate, soil, biota, and other features. From west to east these regions include the Coast; Southern Oregon; Willamette Valley; Cascades; Deschutes-Columbia; Blue Mountains-Wallowas; Southeastern Lake; and the Snake River. As regards the crane-fly fauna, certain of these areas are much more important than others and are discussed in more detail.

The Coast Region.—This includes the Oregon Coast Range, comprised of low rolling mountains that have a mean elevation of less than 2,000 feet, the highest point (Marys Peak) attaining 4,097 feet. Between the mountains and the ocean lies the narrow Pacific coastal plain where the western foothills of the range leave only a narrow margin of plain, or, in places, actually jut into the sea as rocky headlands. Many streams rise in the Coast Range and flow westward into the Pacific while others flow eastward into the Willamette River, as discussed later under the Willamette Region. In the south, two rivers, the Rogue and the Umpqua, originate in the western slopes of the Cas-

¹ The preceding part under this general title was published in THE AMERICAN MIDLAND NATURALIST 42: 257-333, 1949.

References in the text refer to the bibliography at the conclusion of the general account.

In the report the author's name has been abbreviated to the initial "A" following records of specimens. M. M. Alexander—Mrs. Charles P. Alexander.

cares and completely traverse the Coast Range, flowing into the Pacific. Peck (1941) in his study of plant distribution divides the present region into four areas, a south and north coast and a south and north mountain, all well distinguished by peculiarities of distribution in the higher plants.

Numerous and very important collections of crane-flies have been made throughout the Coast Region, including the Coast Range, particularly by the Fenders, but with smaller series having been taken by Albright, Davis, Macnab, Post, Scullen, Townes, and others. Of particular significance are the collections made by Professor James A. Macnab, assisted by co-workers and former students at Linfield College, in an area on Saddle Mountain, in northeastern Lincoln County (Macnab, 1945; Dirks-Edmunds, 1947). Extensive series of these flies have been taken by Fender at Gualdo Falls and at High Heaven, in Yamhill County. The highly important series of crane-flies taken by Fender on Peavine Ridge, in the eastern foothills of the Coast Range in Yamhill County, are here construed as falling more properly in the Willamette Region and will be discussed thereunder.

The Southern Oregon Region.—Extends from the Calapooya Mountains in Lane and Douglas counties southward to the California state line, lying chiefly between the Coast Range and the Cascades, including the complex mountain mass formed by the close approximation or union of the Cascades, Coast Range, Klamath Mountains and the Siskiyou. The section lying between Eugene and Roseburg, a distance of some 50 miles in length by from 10 to 20 miles in width, while not considered as being "Coast Range" by the local inhabitants, according to Fenneman (1931: 419, 435, 459-460) is quite comparable in its altitude and relief to a large part of the Oregon Coast Range and is placed by him in the same physiographic section. Peck (1941) recognizes two separate districts, the Siskiyou of the south coastal area and the Rogue-Umpqua area lying more inland. The Tipulidae of this region are but little known, the chief collections having been made at Ashland, Grants Pass and Medford, and in the Siskiyou National Forest.

The Willamette Region.—This is comprised essentially of the Willamette Valley, a roughly rectangular trough, nearly 180 miles in length, extending from the Columbia River in the north to the Calapooya Mountains, in width extending some 60 miles from the Cascades to the Coast Range. The region is drained by the Willamette River and its tributaries, including a total area of some 11,200 square miles, producing the most important agricultural, commercial and industrial parts of the state and with approximately two-thirds of the entire population.

The western slopes of the Cascades, with its foothills, comprise some 60 percent of the total area of the Willamette Basin. This is traversed by many deep valleys that have been cut by glaciers and streams, some of these valleys being fully 1,000 feet in depth. The Coast Range, forming the western boundary of the basin, obstructs part of the moisture-bearing winds from off the Pacific but because of the average low height of the range, large quantities of moisture reach the Willamette Basin. At the lower end of the valley, the Calapooya Mountains separate the Willamette River from that of the Umpqua River to the south. Numerous tributary streams originate in both the Coast Range and in the Cascades, particularly the latter. The Middle Fork of the Willamette River rises in a small lake near the summit of the Cascades at near 6,000 feet, flowing northwestward, near Eugene uniting with

the Coast Fork, in its course dropping some 5,600 feet in a distance of approximately 90 miles. Similar steep slopes characterize most of the principal tributaries that originate in the Cascades, from north to south these including the Clackamas, Molalla, Santiam and McKenzie Rivers. Most of the Coast Range tributaries are shorter, originating on the east slope of the mountains, and entering the Willamette River from the west. From north to south, the chief of these are the Tualatin, Yamhill, Luckiamute, Marys and Long Tom Rivers. The floor of the Willamette Valley is generally flat while sloping gently to the river's mouth, where it unites with the Columbia some twelve miles above Portland. Several hills rise above the comparatively level valley but none exceeds a few hundred feet in height. The main channel of the river follows a meandering course, with many oxbows, sloughs and overflow channels, as commonly found in alluvial valleys. The valley and its topography and climate have been discussed in detail by Brands (1947).

Numerous collections of Tipuloidea have been made at stations in the valley, including several by Fender from the actual banks of the Willamette River in the vicinity of Dayton, yielding certain of the species characteristic of the banks and margins of major streams. Other important valley stations include the leading educational centers of Corvallis and Eugene, particularly the former, where the entomologists and students of the Oregon State Agricultural College have amassed considerable collections of these flies during past years. Likewise included in the valley are the beautiful Silver Creek Falls in Marion County. More to the north, McMinnville, home of the Fenders, who are cited constantly throughout this report, and Forest Grove, where Cole collected various species (Cole and Lovett, 1921), are similarly typical valley stations. Furthermore, the most important single station discussed in this paper, Peavine Ridge, in Yamhill County, on the eastern slopes of the Coast Range, where Fender has made most noteworthy discoveries in many groups of insects (Fender, 1948) is construed as falling in this region, as discussed in more detail hereinafter.

The Cascade Mountains.—Under the discussion of the state of Washington in the preceding part under this same title (Alexander, 1949) the general features of the Northern Cascades were outlined. In Oregon, the range completely traverses the state from north to south, there passing into California where it terminates near Lassen Peak. In Oregon, virtually the entire range is comprised of the Middle Cascade Mountains, where distinct evidences of crustal uplift are shown, particularly in the north, additional to and contrasting with the gradual accumulations of volcanic andesitic lavas by which the Southern Cascades have been built up. On the northern boundary, the Columbia River, in forming its great east-west gorge, has cut through thousands of feet of lava. The general crest level of the Oregon Cascades is between 5,000 and 6,000 feet, this surface being studded at infrequent intervals by towering extinct volcanoes, the summits of the higher ones being permanently snow-covered or even provided with glaciers. From north to south, the chief peaks of the Cascades include Mount Hood (11,253 feet), highest point in Oregon; Mount Jefferson (10,495 feet); Mount Washington (7,769 feet); the Three Sisters (North Sister, 10,094 feet; Middle Sister, 10,053 feet; South Sister, 10,354 feet); Mount Thielsen (9,178 feet); ancient Mount Mazama and its relict, Crater Lake (6,117 feet); and, in the south, Mount McLoughlin (9,493 feet).

Collections of Tipuloidea in the Oregon Cascades have been very numerous and of extreme interest. The majority of these have been taken in the vicinities of Mount Hood and Crater Lake, as detailed later (under "Collecting Stations"). The intervening section of the Cascades is less accessible and hence not as well known but some interesting records are available from stations along the North Santiam River, South Santiam River, Metolius River, Deschutes River, Century Drive out of Bend, vicinity of the Three Sisters, and along the crest of the Cascades near the headwaters of the Middle Fork of the Willamette River, the vicinity of Odell Lake, and at beautiful Salt Creek Falls.

Deschutes-Columbia, Southeastern Lake and Snake River Regions.—The eastern slopes of the Cascades merge into the great interior plateau that lies between them and the Blue Mountains in the east. Drainage from the eastern slopes of the Cascades is chiefly into the Deschutes River and thence northward into the Columbia. Still farther east the John Day and Umatilla Rivers originate in the interior of the state and likewise flow north into the Columbia. This great basaltic plateau is formed by the Columbia lava flow which further occupies much of Idaho and eastern Washington, including a total of about 100,000 square miles, in places with a thickness exceeding 4,000 feet.

Extensive collections of crane-flies have been made in the eastern Cascades, particularly at Tumalo Creek, near Bend; on the Metolius River, and along the Hood River on the eastern slopes of Mount Hood. All such collections actually pertain to the Cascadean fauna and show few or none of the Great Basin and Rocky Mountain elements that form such a characteristic part of the biota of the Blue Mountains-Wallowas, as discussed later. East of the Cascades, the Columbia Plateau seems to support relatively few species of Tipulidae, except on the higher and damper mountains where there is a coniferous forest, as on the Ochocos. To the southeast the plateau merges into the Great Basin and certain of the species of Tipulidae so far discovered here are characteristic Rocky Mountain and Great Basin forms. This part of Oregon comprises the Southeastern Lake Region, with numerous dry, semi-permanent and permanent lakes. The isolated Steens Mountains have produced very few species of Tipulidae but this may well be due to insufficient collecting. These rugged mountains constitute a boldly tilted uplift jutting above the plain of lava.

The Snake River Region is similarly very poor in Tipulidae but is still insufficiently known. It includes a narrow strip along the eastern boundary of the state, consisting of an open basaltic plateau averaging some 3,500 to 4,000 feet in altitude, with low mountains and narrow river valleys. The Snake River, a major tributary of the Columbia, forms its great canyon along the northern half of the eastern border of Oregon, reaching a maximum depth of 5,500 feet opposite the Wallowa Mountains.

Peck (1941), working on the distribution of the flora, subdivides eastern Oregon into five areas that he terms the Columbia River, Yellow Pine, Bunchgrass, Sagebrush, and Lake Sections. The Yellow Pine includes a zone fringing the eastern base of the Cascades, western base of the Blue Mountains, and the lower slopes and summits of various short mountain chains lying within the Great Basin territory, lacking in the Steens Mountains.

Blue Mountain-Wallowas Region.—This includes an area of approximately 20,000 square miles in northeastern Oregon, containing the exceedingly inter-

esting Blue and Wallowa Mountains. As indicated by Fenneman (1931: 248), the Blue Mountains in Oregon and southeastern Washington are contiguous with the Northern Rocky Mountain Province in Idaho, being separated therefrom only by the canyon of the Snake River, a distance of about 15 miles from rim to rim.

The Blue Mountains are actually a composite of several separate ranges, one of these being the Elkhorn Ridge, west of Baker City, where the most important collections of crane-flies known from the entire region have been taken by Mr. James H. Baker, as discussed later (under "Collecting Stations"). Further important materials from the Blue Mountains have been taken at and near Langdon Lake and on the Upper Walla Walla River, close to the Washington state border. North of this the Blue Mountains pass into extreme southeastern Washington, or virtually to the Snake River opposite Lewiston, Idaho.

The more rugged and imposing Wallowas include an island of some 25 miles in diameter surrounded by the sea of basalt comprising the Blue Mountain Plateau. The mountain mass is chiefly of non-volcanic rocks, including granites, quartzite, limestone and slate. In topography, the Wallowas are much like the Rocky Mountains and it is well known that many Rocky Mountain species of plants and animals occur here. The peaks of the range are sharp and jagged, separated by steep cirques and deeply cut canyons. The highest peaks are just over 10,000 feet in height. There are numerous small mountain lakes that give rise to torrential streams, particularly during the summer months when the melting snow and ice provide abundant water. This is well shown in the beautiful Lostine Valley, where we collected in June and in August 1948, as discussed later. On the eastern base of the mountains lies the largest lake, Wallowa, at about 4,400 feet.

Climate.—The general climate of Oregon is like that of Washington, with much of the rainfall occurring in the western third of the state, east of the Cascades the country being unusually dry to semi-desert, excepting on the higher mountains. The prevailing westerly winds bring abundant rains but comparatively little passes the Cascades. The heaviest rains fall on the slopes facing the ocean, in general increasing from near the coast to near the summit of the Coast Range, thence decreasing in amount in the valleys of the Willamette, Umpqua and Rogue Rivers, again increasing to certain altitudes on the Cascades. On the eastern slopes of this range and eastward there is a rapid decrease in precipitation, with the amount again increasing on the Blue Mountains. The annual average precipitation reaches nearly 130 inches at some Pacific Slope stations (as Glenora, Tillamook Co.), falling to less than 8 inches in the dry eastern parts of the state (as Umatilla; Harper, Malheur Co.; Lake Co.; Andrews, Harney Co.). Precipitation is seasonal, showing influences of the Mediterranean type of climate in the great preponderance of rainfall in winter over that of summer. West of the Cascades, 44 percent falls in winter, 24 in spring, 5 in summer and 27 in the autumn; east of the Cascades, 37 percent falls in winter, 27 in spring, 12 in summer and 24 in autumn. Snow seldom falls on the coastal areas and rarely persists, the winter of 1948-49 having been unusually severe in this regard. The average annual snowfall ranges from less than one inch on certain coastal stations to more than 40 feet in the Cascades.

The mean annual temperature ranges from about 56° Fahr. in the lower

Snake River Canyon in extreme northeastern Oregon to about 38 in the Cascades (not including the highest points, from which no records are available). January minimum temperatures normally range between 12 and 40 degrees, with the greatest extremes occurring over the high eastern plateau. July maximum temperatures normally range between 65 on the middle and southern coastal stations to 95 in the Snake River Canyon. The great gorge of the Columbia River permits the transfer of continental air masses into western Oregon, particularly in the winter, producing lower temperatures than would otherwise be the case.

The following stations are selected from the detailed state records as given by Wells, in *Climate and Man* (1941: 1075-1086).

| Station | Temperatures (in Fahrenheit degrees) | | | | Precipitation (in inches) | | |
|--------------------------|--------------------------------------|----------|------|------|---------------------------|------|--------|
| | Jan. av. | July av. | Max. | Min. | Jan. | July | Annual |
| Baker | 24.9 | 65.6 | 104 | -24 | 1.09 | 0.44 | 10.69 |
| Corvallis | 39.3 | 65.9 | 106 | -14 | 6.63 | 0.32 | 40.06 |
| Crater Lake | 26 | 56.6 | 100 | -20 | 9.66 | 0.59 | 58.29 |
| Forest Grove | 37.4 | 66.1 | 108 | -15 | 7.42 | 0.37 | 45.88 |
| Mount Hood-Govt. Camp .. | 30.3 | 56 | 96 | -16 | 12.28 | 1.52 | 84.81 |
| Hood River | 32.9 | 67.3 | 106 | -27 | 4.78 | 1.17 | 30.06 |
| McMinnville | 38.9 | 66.3 | 110 | -24 | 7.00 | 0.38 | 42.15 |
| Salem | 39.7 | 66.6 | 108 | -6 | 5.61 | 0.39 | 37.24 |
| Wallowa | 24.4 | 65.4 | 108 | -38 | 1.78 | 0.59 | 16.81 |

Biotic and Physical Provinces.—Dice (1943) recognizes four of his biotic provinces in the state. The heavy coniferous coastal forest, called by him the Oregonian and herein termed the Vancouverian, occupies the Coast, the formerly wooded Willamette Valley, and the Middle Cascades, the dividing line being placed at The Dalles on the Columbia River and thence southward just east of the crest of the Cascades. From the south, the Californian province extends into the state, in the southwest lying inside the coast and including the valleys of the Rogue and Umpqua Rivers, extending northward in the Cascades to near Crater Lake. The dry eastern plateau is occupied by the Palusian province in the northeast, including and encircling the Blue and Wallowa Mountains. The more extensive southeastern part of Oregon includes the great sagebrush covered plains of the Artemisian province, Great Basin country extending as far west as the Cascades where it meets the Vancouverian and Californian provinces, as described. The local distribution of the *Tipuloidea* in Oregon substantiates the limits of the provinces as defined by Dice.

Fenneman (1931) recognizes three physiographical provinces, the Pacific Border Province, including the Oregon Coast Range section in the north and the Klamath Mountain section in the south. The Cascade-Sierra Mountains Province extends the entire length of the state along the Cascades. The entire eastern part of Oregon is occupied by the Columbia Plateaus Province, with four of the five sections occurring within the state, the Walla Walla Plateau in the northwest, Blue Mountain in the northeast, Payette in the southeast, and Harney in the south.

In similar manner, Mulford, in Van Dersal (1938) classifies the state on the basis of plant-growth and soil regions and climatic provinces. From west to east in Oregon the plant growth regions include the North Pacific Coast; Willamette Valley-Puget Sound; Cascade-Sierra Nevada; a very slight intrusion of the Columbia River Valley in the extreme north; a major northward extension of the Great Basin-Intermontane region in the southeast, and a comparable major arm of the Snake River Plain-Utah Valley in the northeast, the last enclosing an isolated island of the Northern Rocky Mountains region that includes the Blue Mountains and the Willows.

Peck (1941: 10-30) recognizes no fewer than nine areas based upon the distribution of the higher plants, providing a short discussion and detailed lists of the characteristic plant species of each of these. The areas are the Northern Coast; Northern Coast Mountain; Willamette Valley; Rogue-Umpqua; Southern Coast; Southern Coast Mountain and Siskiyou; Cascade; Eastern Oregon; Blue Mountain, including the Willows.

Life Zones.—The most detailed account of the life zones of the entire state is that provided by Bailey (1936: 11-53, colored map, figs. 1-6, showing the distribution of the zones on Mounts Hood, Jefferson, Three Sisters, McLoughlin, Willows and Steens Mountains). Five of the Merriam zones are represented in Oregon, the lowest being the Upper Sonoran (Upper Austral) which occupies the low valleys east of the Cascades, west of the mountains including the valleys of the Rogue and Umpqua Rivers. The Transition zone includes the higher valleys and foothills, showing a more humid subdivision in the valley foothills and on the Coast Ranges west of the Cascades. The Canadian zone forms a wide belt higher in the mountains, while the Hudsonian zone occupies a narrower belt on the higher peaks, extending to timber line. The highest zone, the Arctic-Alpine, is much restricted in area, including the treeless summits of the highest peaks. As regards the Tipulidae, the most important zones are the humid portions of the Transition and Canadian, with fewer species occurring in the Hudsonian and Upper Sonoran.

Crater Lake National Park.—A detailed survey of the life zones of the vicinity of Crater Lake has been given by Wynd (1941). This shows that only three zones are present, the Transition being found in the lowest portions of the Park to about 5,500 feet; the Canadian from about 5,500 to 6,250 feet, and the Hudsonian from 6,250 feet to the highest altitudes in the Park (Mount Scott, east of Cloudcap, 8,938 feet). As shown by Wynd, the upper limits of these zones range from 1,200 to 2,500 feet higher than the corresponding zones on Mount Rainier, Washington, some 275 miles to the north (Alexander, 1949: 261).

General Survey of the Tipuloidean Fauna of Oregon

The accompanying record includes 317 species of Tipuloidea as determined to this time, Oregon having by far the largest list of these flies as known for any western state or Canadian province, with the single exception of California. It appears certain that when fully known, the Oregon list will exceed 400 species. Numerous additions may be expected from the north and south, but especially from the east, where various species representing the Rocky Mountain and Great Basin elements should be found to occur.

The altitudes of the various zones on the six mountains listed above are given herewith (adapted from Bailey).

| Mountain | Zone | Upper limit— NE slopes | Upper limit— SW slopes |
|--|---------------|---------------------------------------|---------------------------|
| Mount Hood (Base level 500 feet) | Sonoran | 1,000 feet | — |
| | Transition | 3,000 | 4,000 |
| | Canadian | 5,000 | 6,000 |
| | Hudsonian | 6,000 | 7,000 |
| | Arctic-Alpine | (Summit—11,253 feet) | |
| Mount Jefferson (Base level 1,500 feet) | Sonoran | 2,000 | — |
| | Transition | 3,500 | 4,500 |
| | Canadian | 5,500 | 6,500 |
| | Hudsonian | 6,500 | 7,500 |
| | Arctic-Alpine | (Summit—10,495 feet) | |
| Three Sisters Peaks (Base level 1800 South 3500 North) | Sonoran | — | — |
| | Transition | 4,500 | 4,800 |
| | Canadian | 6,000 | 7,000 |
| | Hudsonian | 7,000 | 8,000 |
| | Arctic-Alpine | (Summit, South Sister, 10,354 feet) | |
| Mount McLough- lin (Pitt) (Base level 1,400 South 4,000 North) | Sonoran | 3,500 | 2,500 |
| | Transition | 5,000 | 5,000 |
| | Canadian | 7,000 | 7,200 |
| | Hudsonian | 8,000 | 8,200 |
| | Arctic-Alpine | (Summit—9,493 feet) | |
| Wallowa Mountains (Base level 3,000 South 1,500 North) | Sonoran | 2,800 | 3,500 |
| | Transition | 4,800 | 5,800 |
| | Canadian | 7,000 | 8,000 |
| | Hudsonian | 8,000 | 9,000 |
| | Arctic-Alpine | (Summit, Sacajawea Peak, 10,033 feet) | |
| Steens Mountains (Base level 4,500 South 4,000 North) | Sonoran | 4,200 | 5,000 |
| | Transition | 6,000 | 7,000 |
| | Canadian | 7,500 | 8,500 |
| | Hudsonian | 8,500 | 9,000 |
| | Arctic-Alpine | (Summit—9,354 feet) | |

Of particular interest is the occurrence of two species of the so-called Primitive Crane-flies, Tanyderidae, which are among the most generalized of all living Diptera. Actually this family belongs to the superfamily Psychodoidea but since it has always been considered as being a crane-fly is included here for completeness. The Ptychopteridae and Trichoceridae are unusually well represented in the state. In the Tipulidae proper, the great genus *Tipula*, largest single genus in the fauna, includes 68 species. The small tribe Pediciini, a group characteristic of northern faunas, includes the unusually high number of 39 species (compare also the state of Washington, Alexander, 1949). The Limoniini have 43 species, the Hexatomini 45. As is usual throughout the north temperate zone, the small-sized Tipulidae belonging to the tribe Eriopterini are the most numerous in species, the 95 here listed including nearly a third of the entire fauna.

Very many of the species of Tipulidae in the state, particularly of the Cascades and westward, are characteristic of the Vancouverian biotic area, as considered in the preceding paper under this general title (Alexander, 1949). A large percentage of such forms evidently do not cross the Cascades to the east but a considerable number do cross the mountains in the northern part of their range and some, at least, occur as far east as Flathead Lake and the Continental Divide in western Montana.

Hatch (1949: 16) briefly considers the above type of distribution and further calls attention to cases in the Coleoptera where various species, of which a few are listed by name, range entirely across North America from the Atlantic states to the eastern foot of the Cascades while apparently being unable to extend their range farther to the west and so reach the Pacific coast. An analysis of the Tipuloidea of the present list, a total of 317 species, shows only three having a distribution of this type, these being *Nephrotoma ferruginea*, *Limonia* (*Dicranomyia*) *gracilis* and *L. (D.) piscataquis*. Thirteen further species extend from the Atlantic states to the Pacific, these being *Diazosma subsinuata*, *Tipula* (*Lunatipula*) *dorsimaculata*, *Limonia* (*Rhipidia*) *lecontei*, *L. (Dicranomyia)* *halterata*, *L. (D.) humidicola*, *L. (Geranomyia)* *diversa*, *Ula paupera*, *Dicranota* (*Rhaphidolabis*) *cayuga*, *Limnophila* (*Phylidorea*) *claggi*, *Pilaria imbecilla*, *Erioptera* (*Trimicra*) *pilipes*, var., *Ormosia* (*Ormosia*) *manicata* and *Molophilus* (*Molophilus*) *perflavescens*. It should be noted that some of the above have an even more extensive range, occurring also in Eurasia or, in cases, extending southward into Mexico or beyond. A further group of species extends from the Atlantic states to either the Blue or Wallowa Mountains, or both, but not beyond this general longitude, such crane-flies including *Trichocera garretti*, *Tipula* (*Lunatipula*) *macrolabis*, *Limonia* (*Limonia*) *tristigma*, *L. (Metalimnobia)* *cinctipes*, *L. (Discobola)* *annulata*, *L. (Rhipidia)* *fidelis*, and *L. (Dicranomyia)* *morioides*. A small group of forms extend from the Atlantic to the valley of the Willamette River, that is, have crossed the Cascades but, as known to this date, have not reached the counties of the Pacific coast. This list includes *Limonia* (*Dicranomyia*) *brevivena*, *L. (D.) iowensis*, *L. (D.) longipennis*, *L. (Geranomyia)* *communis*, *Ula elegans*, *Erioptera* (*Erioptera*) *dyari*, *E. (E.) septemtrionis*, and *E. (Symplecta)* *cana*. Here again it should be noted that some of the species in the last two categories have a much wider range, being found also in Eurasia, and their non-occurrence on the Pacific coast seems to be a question of further collecting rather than actual distribution.

The apparent reason for the failure of many eastern North American Tipulidae to pass westward of the Rocky Mountains would seem to be the barrier of the Great Basin and other extensive arid or semiarid regions in the west. The developmental stages of most Tipulidae are very dependent on moisture and their distribution is greatly influenced by the presence or absence of water.

Our knowledge of Oregon crane-flies dates only from the present century. Aldrich, in his *Catalogue of North American Diptera*, 1905, recorded only two species of these flies, *Tipula albofascia* and *T. usitata*, described by Doane in 1901 from Corvallis. The basic list of the Diptera of Oregon is by Cole and Lovett (1921) where a total of 953 determined species are recorded, of which 50 fall in the Tipuloidea, as here treated. Virtually all such species were taken by Cole at Forest Grove and Hood River or were contained in the

early collections made at and near Corvallis by Chamberlin, Lovett, Moulton and other early workers at the State Agricultural College. The present writer was responsible for the identifications of crane-flies in this list and despite insufficient knowledge of the fauna at the time, mis-determinations are surprisingly few in number (*Dicranomyia stigmata* Doane becomes *libertoides* Alexander; *Dicranoptycha sobrina* Osten Sacken becomes *stenophallus* Alexander; *Limnophila cressoni* Alexander becomes *L. vancouverensis* Alexander). It may be noted that in this list the records for *Nephrotoma californica* (Doane) and *Tipula californica* Doane (Nos. 26 and 35) actually refer to a single species.

During the 1930s and later, important additions were made by Professor H. A. Scullen and associates at the State Agricultural College. The great development in our knowledge of the state fauna came during the present decade and chiefly within the past five years. Mr. Kenneth M. Fender, to whom much of the success of the present record is due, has devoted a great amount of time to the collection of several thousand specimens of these flies throughout the state. In 1946, 1947 and 1948, Mrs. Alexander and I spent considerable periods of time in Oregon and added numerous records to the list, as described more in detail later. Various other entomologists and collectors have added to our knowledge of the group and these are listed later under "Collectors and Localities" and under the Acknowledgements.

COLLECTING STATIONS

Certain localities where Mrs. Alexander and the writer have collected in person are discussed herewith. In 1946, we were in Oregon between August 1st and 9th, from the 7th to the 9th camping at various stations on the Mount Hood Loop with Fender and Macnab. In 1947, between July 11th and 19th, we again camped on the Mount Hood Loop with Fender. In 1948, a considerable part of the entire summer was spent in the state. Between June 24th and July 5th, the Blue Mountains and Wallows were stressed, for a part of the time with Baker. From July 29th to August 9th, a trip down the Cascades from Mount Hood in the extreme north to the Siskiyou in the southwest, and thence into California, in company with Fender, proved to be one of the most enjoyable and successful trips we have ever had. Between August 16th and 20th, we again returned to the Blue and Wallowa Mountains, in order to secure the late-season Tipulidae. At this time we did some collecting in the Ochoco Mountains and in the John Day country in eastern Oregon.

A few selected stations having more than usual interest are considered in some detail.

COAST RANGE: SADDLE MOUNTAIN, "BOYER"

An area of humid coniferous forest in the Oregon Coast Range, located on the north side of Saddle Mountain, in northeastern Lincoln County, at an average altitude of 1,400 feet. The station is reached from Highway 18, being about six miles south of the highway and some six miles west of Grand Ronde. The name "Boyer," often used in conjunction with this survey, refers to a filling-station on the highway near the road into the station. A detailed study of the ecology of the area was made by Professor James A.

Macnab and students between 1932 and 1938. The actual survey was conducted for some five years, during which period weekly visits were made to the area. In more recent years the whole study area was badly de-forested. The following brief account is adapted from the more detailed records published by Dirks-Edmunds (1947) and Macnab (1944).

The forest canopy of the area at the time the survey was made was composed of Douglas fir, *Pseudotsuga mucronata* (Raf.) Sudw., with fewer Noble fir, *Abies nobilis* Lindl. Western hemlocks, *Tsuga heterophylla* (Raf.) Sarg., formed an understory, varying from small saplings to mature trees of some 150 feet in height. The shrub layer of the community consisted of species of huckleberry, *Vaccinium ovalifolium* Smith and *V. parvifolium* Smith, with salal, *Gaultheria Shallon* Pursh, Oregon grape, *Berberis nervosa* Pursh, and some devil's club. The herbaceous growth was principally seasonal in its appearance, including sword fern, *Polystichum munitum* (Kaulf.) Presl., wood rush, *Luzula parviflora* (Ehrh.) Desv., false solomons seal, *Smilacina*, sp., *Trillium ovatum* Pursh, *Maianthemum bifolium kamschaticum* (Gmel.) Jeps., *Clintonia uniflora* (Schult.) Kunth., fairy bells, *Disporum oregonum* (Wats.) B. & H., twayblade, *Listera* sp., vanilla leaf, *Achlys triphylla* (Smith) DC, *Dentaria tenella* Nutt., cool-wort, *Tiarella* sp., *Oxalis oregana* Nutt., *Moneses uniflora* (L.) Gray, with occasional saprophytic orchids, *Corallorhiza*, sp. The forest floor and prostrate rotting logs were carpeted by mosses, the two most common species being *Rhytidiadelphus loreus* (L. Hedw.) Wainst., and *Hylocomium splendens* (Hedw.), the ground mat averaging approximately 6 cm. in thickness. The Tipuloidea recorded from the area total some 30 species that are listed throughout this report under the name Saddle Mountain (Boyer).

WILLAMETTE VALLEY AND EASTERN FOOTHILLS OF THE COAST RANGE: PEAVINE RIDGE

As has been indicated elsewhere, the survey of the Tipuloidea of Peavine Ridge, as conducted by Fender, has proved to be of most unusual interest and value. Before collecting of these flies on the Ridge was begun, the recorded list of species from all Oregon totalled approximately 70 and it is of interest to note that from Peavine Ridge alone Fender has taken 134 species of Tipuloidea. The reasons for this virtually unparalleled local list result from the diligence and care of the collector and the fact that specimens have been taken almost daily over a period of several years, rendering the list unusually complete. The total area studied totals scarcely more than five acres and it is my belief that the present list of crane-flies may be the largest ever recorded from so limited an area.

The following account is digested from Fender's basic account of Peavine Ridge (1948). The Ridge forms the eastern base of the Oregon Coast Range in Yamhill County, almost due west of McMinnville. The survey area extends for a distance of about four miles in a general direction extending from the southeast to the northwest. Over this distance a total of five major stations, numbered 1, 2, 3, 3A and 4 were established by Fender. All of the stations, with the exception of 4, are provided with small water-courses, an important factor in the consideration of the present group of flies.

Station 1; elevation 210 feet: This has the largest stream of any of the

areas selected but even this dries up in spots during particularly warm summers. The dominant tree is Oregon ash, *Fraxinus oregana* Nutt., with broad-leaf maple, *Acer macrophyllum* Pursh, and Oregon oak, *Quercus Garryana* Dougl., as subdominants. The shrub layer is composed largely of Oregon grape, *Berberis aquifolium* Pursh, and salmon berry, *Rubus spectabilis* Pursh. A fern layer of sword fern, and various rushes is present. Water hemlock, *Cicuta Douglasii* (DC) C. & R., and grasses abound in the herb layer.

Station 2; elevation 600 feet: Rather open, most of the trees being young, the area having been cut over about 1914. Oregon ash and willows, *Salix*, sp., are the dominant trees. The most abundant shrubs are western hazel, *Corylus californica* (A.DC) Rose, poison ivy, *Rhus Toxicodendron* L., and salmon berry. Brake, *Pteridium aquilinum pubescens* Underw., snowberry, *Symphoricarpos albus* (L.) Blake, and sword fern, comprise most of the fern layer, with grasses, St. Johns wort, *Hypericum perforatum* L., water hemlock, and the common monkey-flower, *Mimulus guttatus* DC, composing the majority of the herb layer. Two small temporary streams converge at this station, forming a small meadowland.

Station 3; elevation 605 feet: This is only a short distance from Station 2, yet conditions are very different. A small permanent spring rises in the middle of the area. The predominant trees are Douglas fir and broadleaf maple. Salmonberry and willows are the most abundant shrubs, with sword fern, giant chain fern, *Woodwardia fimbriata* (J. E. Smith) and Oregon grape dominating the fern layer and species of Umbelliferae the herb layer. At this station the first encroachment of the Douglas fir subclimax forest is found and provides the best example of this forest type in the area.

Station 3 A; elevation 980 feet: Smallest of the five areas; close to the road from which it is concealed by overhanging fir branches. Although small in size, this has been one of the most productive of the stations. Oregon alder, *Alnus rubra* Bong., and broadleaf maple are the dominant trees. Important shrubs include the salmon berry, evergreen blackberry, *Rubus laciniata* Willd., and stink currant, *Ribes bracteosum* Dougl. The more important members of the fern layer include the giant chain fern and the brake fern. The herb layer is chiefly choked out but there is one patch of western wild ginger, *Asarum caudatum* Lindl., with occasional smooth woodland violets, *Viola glabella* Nutt., and western trillium.

Station 4, elevation 1,085 feet: A dry station, cut over about 1916 but now coming back to a stand of young Douglas fir and Oregon oak. The shrub layer is composed largely of snowberry, western hazel, and very young Oregon oak. Brake fern comprises the chief constituent of the fern layer. The herb layer includes grasses, English plantain, *Plantago lanceolata* L., and heal-all, *Prunella vulgaris* L. Relatively few Tipuloidae have been taken here, this being explainable in large part by the lack of free water.

On August 6, 1946, I accompanied Mr. Fender on his rural mail route out of McMinnville and so was able to visit and inspect all of the above described stations. From such a brief examination it would seem quite impossible that more than 130 species of crane-flies could occupy such a restricted area. This study by Fender indicates clearly that while Peavine Ridge is unusually rich in various insect groups, including crane-flies, there must remain unlimited numbers of comparable areas throughout the Pacific Northwest awaiting study and the patient care and attention such as has been devoted to

the Ridge by Fender over the past several years. Unfortunately for entomology, there are very few persons with ability, enthusiasm and courage possessed by Kenneth Mark Fender, to whom I express my deepest thanks for having made the Oregon list of Tipuloidea what it is today.

The impressive list of 134 species of crane-flies from the Peavine Ridge stations includes more than 40 percent of all species now known from the state and this proportion will probably be maintained, since it seems certain that still further species of these flies remain to be discovered at the established stations. From other not distant localities, as McMinnville and High Heaven, various further species have been taken, some of which will be found to occur on the Ridge. A considerable number of species of Tipuloidea described by the writer were based originally either wholly or in part on Fender's Peavine Ridge materials. These include *Bittacomorphella fenderiana*, *Trichocera hyaloptera*, *Tipula* (*Lunatipula*) *diabolica*, *T. (L.) fenderi*, *T. (L.) macnabi*, *Dicranoptycha melampygia*, *D. stenophallus*, *Paradelphomyia* (*Oxyrhiza*) *deprivata*, *Cladura* (*Cladura*) *nigricauda*, *Lipsothrix fenderi*, *Gonomyia* (*Gonomyia*) *percomplexa*, *Erioptera* (*Psiloconopa*) *irata*, *Ormosia* (*Ormosia*) *furibunda*, *O. (O.) pleuracantha*, *O. (O.) upsilon*, *Tasiocera* (*Dasy-molophilus*) *squiresi*, *Molophilus* (*Molophilus*) *oregonicolus*, and *M. (M.) suffalcatus*.

CASCADES: MOUNT HOOD

As indicated earlier, in our own collecting very particular attention was devoted to the vicinity of Mount Hood and to Crater Lake National Park. A small group of stations are chosen as being representative of many other comparable ones throughout the Cascades.

The stations in the vicinity of Mount Hood where collecting has been done, mostly in company with Fender, are as follows: Barlow Pass, 4,160 feet; Bear Creek, 1,400; Bear Springs Forest Camp, Wapinitia cutoff, 3,200; Beaver Creek, 1,150; Clackamas Lake (Oak Grove Fork of Clackamas River), 3,300; Cloud Cap Inn, 5,985; Eagle Creek Forest Camp, 300; Government Camp, 3,870; Hood River Meadows, 4,480-4,500; Horsethief Meadows, 3,400; Iron Creek, 4,400; Kelly Creek, Wapinitia Cutoff; Polally Forest Camp, 3,000; Robin Hood Forest Camp, 3,560; Sahale Falls, 4,575; Sherwood Forest Camp, 3,100; Still Creek, 3,600-3,800; Tilly Jane Forest Camp, 5,600-5,700; Wapinitia Cutoff. The various waterfalls along the Columbia River, all having an approximate altitude of 100 feet at the base, include Horsetail Falls, Multnomah Falls, Oneonta Gorge and Wahkeena Falls.

Bear Creek (Faubion); elevation 1,400 feet: Throughout the Humid Transition and into the Canadian zone of the Pacific Northwest are found low-lying areas where western skunk cabbage and Oregon alder are dominant. Such areas are of unusual interest as regards their Tipulid fauna and well repay detailed collecting and study. As representative of such areas, the one here indicated is discussed. In the low swampy land adjoining Bear Creek occurs a rank dense growth of western or yellow skunk cabbage, *Lysichitum americanum* St. John, with a sparse open forest cover consisting chiefly of Oregon alder and vine maple, *Acer circinatum* Pursh. Associated herbs include rank growths of ferns, with some hellebore, *Veratrum*, great hedge nettle, *Stachys ciliata* Douglas, and various others. On the more elevated

hummocks and dryer margins of the area grow salal and Oregon grape, with associated herbs, including wood sorrel and *Maianthemum*. Scattered around the swamp margins are a few devils club, *Olopanax horrida* (Smith) Miguel.

Tipulidae in this area are very numerous, as shown by the accompanying list. Those species that are especially characteristic of, though not necessarily restricted to, the habitat are indicated by an asterisk (*). *Ptychoptera sculleni*,* *P. townesi*, *Bittacomorpha occidentalis*, *Diazosma subsinuata*, *Tipula* (*Bellardina*) *aspera*,* *T. (B.) pacifica*, *T. (Lunatipula) megalabiata*,* *T. (Hesperotipula) streptocera*, *Limonia (Limonia) bistigma*,* *L. (L.) sciophila*,* *L. infusata*, *L. (Discobola) elegans*,* *L. (Rhipidia) lecontei*, *L. (Dicranomyia) particeps*, *Pedicia (Tricyphona) aperta*, *P. (T.) bicomata*,* *P. (T.) constans*,* *P. (T.) unigera*, *Dicranota (Rhaphidolabis) xanthosoma*, *D. (Plectromyia) cascadia*, *Limnophila (Prionolabis) indistincta*,* *L. (Dendrolimnophila) albomanicata*,* *L. (Phylidorea) euxesta*, *L. (P.) rubida*,* *L. occidentens*, *Ulomorpha sierricola*, *Ormosia (Ormosia) buceri*,* *O. (O.) decusata*,* *O. (O.) fusiformis*, *Molophilus (Molophilus) perflavescens*.*

In virtually similar plant associations at higher altitudes, as at Still Creek and Robin Hood Forest Camps, additional species of Tipulidae restricted to these higher levels are found and have been discussed later in the report under the species concerned. Elsewhere in the western skunk cabbage associations throughout the Pacific Northwest, studied in detail by us from western Washington southward into northern California, crane-flies such as *Paradelphomyia (Oxyrhiza) deprivata* and *Ormosia (Ormosia) profunda* were found to be especially characteristic of such habitats.

Hood River Meadows; elevation 4,480-4,500 feet: As representative of the high alpine meadows, the unusually interesting area on the southeast side of Mount Hood, known as the Hood River Meadows, is discussed briefly. A stream of medium size flows through the open meadows that are overgrown with grasses and sedges, together with scattered clumps of shrubby willows. Characteristic herbs in bloom in July and August, at the time of our visits, included hellebore, *Veratrum viride* Ait., abundant green and white species of *Habenaria* orchids, *Caltha leptosepala* DC, *Pedicularis groenlandica surrecta* (Benth.) Piper, *Dodecatheon*, and numerous others. Along the stream and on adjoining dryer banks grow alpine fir, mountain hemlock and some pine. The meadows extend high up onto the slopes of Mount Hood and collections have been made for a distance of nearly one mile or to the Clark Creek crossing.

This is one of the richest areas for Tipulidae in the entire state. In the accompanying list, the asterisk indicates species particularly characteristic of this particular habitat. *Ptychoptera lenis*, *P. sculleni*, *Bittacomorphella fenderiana*,* *Tipula (Yamatotipula) spemax*, *Tipula (Trichotipula) rusticola*,* *T. (Arctotipula) plutonis*,* *T. (Oreomyia) pseudotruncorum*, *Cylindrotoma occidentalis*,* *C. splendens pallescens*, *Limonia (Limonia) bistigma*, *L. (L.) sciophila*,* *L. venusta*, *L. (Dicranomyia) fulva*, *Pedicia (Pedicia) parvicellula*, *P. (Tricyphona) aperta*,* *P. (T.) bicomata*,* *P. (T.) constans*, *P. (T.) cascadiensis*,* *P. (T.) diaphana*, *P. (T.) smithae*, *Dicranota (Polyangaeus) maculata*, *D. (Rhaphidolabis) cayuga*, *D. (R.) integriloba*, *D. (R.) xanthosoma*, *D. (Plectromyia) reducta*,* *Limnophila (Phylidorea) claggi*,* *L. (P.) euxesta*,* *L. (P.) nycteris*,* *L. (P.) olympica*,* *L. (P.) snoqualmiensis*,* *L. occidentens*,* *Ulomorpha sierricola*,* *Erioptera (Mesocyphona) melanderi*.

ana,* *E. (Symplecta) cana*, *Ormosia (Rhypholophus) hoodiana*, *O. (Ormosia) albertensis*,* *O. (O.) onerosa*,* *Molophilus (Molophilus) falcatus*, *M. (M.) kulshanicus*, *M. (M.) rainierensis*.

Sahale Falls: elevation 4,575 feet: Close to the Hood River Meadows on the southeast side of Mount Hood, on the East Fork of Hood River, the ethereal Sahale Falls has cut a small gorge where some unusually interesting northern Tipulidae have been taken by Fender and the writer. It may be noted that while collecting on the wet cliff faces immediately at the falls, a specimen of the ascapid frog, *Ascaphus truei* Stejneger, was taken, resting among the soaking herbage. The characteristic crane-flies of the habitat include *Tipula (Yamatotipula) continentalis*,* *Limonia (Dicranomyia) halterata*, *L. (D.) humidicola*,* *Elliptera astigmatica*,* *Pedicia (Tricyphona) smithae*,* *Dicranota (Dicranota) astigma*,* *D. (Rhapidolabis) integriloba*, *Phyllolabis fenderiana*,* *Limnophila (Phylidorea) claggi*, *L. tetonicola*,* *Erioptera (Hesperoconopa) dolichophallus*,* *Ormosia (Rhypholophus) paradisea*,* *O. (O.) onerosa*, *O. (O.) proxima*,* *Molophilus (Molophilus) perflaveolus*,* *M. (M.) suffalcatus*.

CASCADES: SALT CREEK FALLS

Salt Creek is a major tributary of the Middle Fork of the Willamette River on the western slopes of the Cascades. Above McCredie Springs, at an approximate altitude of between 3,800 and 4,000 feet, are the fine Salt Creek Falls, with a drop of 286 feet into the great gorge formed at their foot. Small lateral streamlets, as well as the slopes of the gorge above the main stream, were carefully swept for insects on July 14, 1947, and again on August 7, 1948, the latter in company with Fender. As before, the most characteristic species are indicated by an asterisk. *Bittacomorpha occidentalis*, *Tipula (Bellardina) aspersa*, *T. (Schummelia) subtenuicornis*,* *T. (Yamatotipula) continentalis*,* *Limonia (Limonia) bistigma*,* *L. (Geranomyia) diversa*,* *L. (Dicranomyia) gracilis*,* *L. (D.) halterata*,* *Elliptera astigmatica*,* *Pedicia (Tricyphona) aperta*, *P. (T.) townesiana*,* *P. (T.) unigera*, *Ornithodes harmani*,* *Ula (Ula) paupera*, *Dicranota (Polyangaeus) maculata*, *D. (Rhapidolabis) xanthosoma*,* *D. (Plectromyia) reducta*, *Paradelphomyia (Oxyrhiza) pacifica*, *Dactylolabis nitidithorax*,* *Limnophila (Prionolabis) antennata*, *L. (P.) indistincta*,* *L. (P.) vancouverensis*, *L. (Dendrolimnophila) albomanicata*, *Ulomorpha vanduzeei*, *Gonomyia (Gonomyia) percomplexa*, *Ormosia (Ormosia) albrighti*,* *Molophilus (Molophilus) perflaveolus*, *M. (M.) spiculatus*.

CASCADES: CRATER LAKE NATIONAL PARK

The striking physical features of Crater Lake have been detailed in various papers cited in the References, provided later (Anon., 1941, 1942; Applegate, 1939; Atwood, Jr., 1935; Bailey, 1936; Diller, 1902; Williams, 1941; Wynd, 1936, 1941).

The stations in the vicinity of Crater Lake where we have collected are as follows: Annie Springs, 6,000-6,015 feet; Castlecrest Garden, 6,800; Cold Spring Forest Camp, 5,900; Lake Rim, 7,075; Lake Shore, 6,177; Lost Creek,

5,900-6,000; Pole Bridge Creek, 3 miles south of Annie Springs, 5,900; Park Headquarters, 6,500; Vidae Falls, 6,500.

We camped at Crater Lake for short periods on three successive years, August 1-4, 1946; July 11-13, 1947, and August 7-8, 1948, the last in company with Fendler. To show the differences in snowfall over different winters, it may be indicated that in August 1946, the trail to the lake shore was blocked by snow drifts and was impassible on the dates in question. The next year, before mid-July, the trail to the lake was open and we were able to descend to the lake level.

Two areas in the Park were found to be exceptionally rich in Tipulidae and were selected for special study.

Castlecrest Garden; elevation 6,800 feet. A restricted boggy area adjoining the road a short distance below the rim of Crater Lake. The area supports scattered shrubby willows and rather numerous species of herbaceous plants, the following being most conspicuous on the dates when the collections of Tipulidae were made: *Dicentra formosa* (Andr.) DC, *Spiraea densiflora* Nutt., *Viola Macloskeyi* Lloyd, *Pedicularis groenlandica surrecta*, and *Mimulus Lewisii* Pursh. Only a few Tipulidae were found but these were very common, including *Tipula* (*Arctotipula*) *plutonis*,* *Pedicia* (*Tricyphona*) *smithae*,* *Gonomyia* (*Gonomyia*) *bihamata*,* and *Erioptera* (*Mesocyphona*) *melanderiana*.*

Pole Creek Meadows; elevation 5,900 feet: An open hillside sloping gradually down to Pole Creek, with numerous cold springs forming small ramifying rills that flow into the main stream, the whole forming an extensive boggy meadow. Great beds of an aquatic or semi-aquatic moss carpet the ground, interspersed with a further rank growth of herbs of many species, including *Equisetum arvense* L., *Habenaria dilatata* (Pursh) Hook., *Polygonum bistortoides* Pursh, *Ranunculus Gormanii* Greene, *Aconitum columbianum* Nutt., *Dodecatheon alpinum* Greene, *Mimulus guttatus* DC, and *Senecio triangularis* Hook. The tree growth on the surrounding higher land includes mountain hemlock, *Tsuga Mertensiana*, shasta fir, *Abies magnifica shastensis* Lemmon, and lodgepole pine, *Pinus contorta Murrayana* (Balf.) Engelm.

Considering the relatively small number of species of crane-flies so far discovered at Crater Lake, the following list of species found on the meadows is surprisingly large. These include *Bittacomorpha occidentalis*,* *Diazosma subsinuata*, *Tipula* (*Yamatotipula*) *continentalis*, *T.* (*Arctotipula*) *plutonis*,* *Pedicia* (*Pedicia*) *parvicellula*, var.,* *P.* (*P.*) *magnifica*, *P.* (*Tricyphona*) *aperta*,* *Dicranota* (*Plectromyia*) *reducta*,* *Limnophila* (*Elaeophila*) *aldrichi*, L. (*Phylidorea*) *claggi*, L. *occidens*,* *Gonomyia* (*Idiocera*) *shannoni* G. (*Gonomyia*) *bihamata*, *Erioptera* (*Mesocyphona*) *melanderiana*,* *E.* (*Psiloconopa*) *rainieria*,* *Molophilus* (*Molophilus*) *colonus*,* and *M.* (*M.*) *rainierensis*.*

It may be noted that specimens of the *Pedicia parvicellula* were found that had evidently just emerged from the saturated mosses. The noon-day temperature of the water at this time, August 3, 1946, was 40° Fahr.

BLUE MOUNTAINS

Collections of Tipuloidea have been made at various places in these mountains, chiefly by Messrs. Baker, Davis, Lane, Scullen, Sperry, and the writer.

The chief localities where these flies were taken are as follows: Anthony Lake, 7,000 feet; Granite, 4,690; Langdon Lake (Tollgate P.O.), 4,970; Lime, 2,225; Little Phillips Creek (Elgin, 2,665, to Langdon Lake, 5,000); Mosquito Creek, Whitney; Pine Creek, 4,500; Spring Creek, 3,900; Upper Walla Walla River, 1,450.

Spring Creek, Whitman National Forest; 14 miles northwest of Baker; elevation 3,900 feet. A beautiful mountain stream flowing from off the slopes of the Elkhorn Ridge, crossing the 40 acre estate of Mr. and Mrs. James H. Baker. Smaller lateral streamlets and boggy spots along the creek provide ideal haunts for Tipulidae. We stayed at the Baker cabin and collected here between June 24 and 28, 1948, and further series of these flies were taken throughout the seasons of 1948 and 1949 by the Bakers, to whom my most sincere thanks are extended for this co-operation. As a result of this, our knowledge of the crane-fly fauna of this section of the Blue Mountains may be considered as being satisfactory.

THE WALLOWA MOUNTAINS

The physical features of this most attractive mountain range have been indicated earlier. The chief localities where crane-flies have been taken include the following: Chief Joseph Mountain, 4,500 feet; Enterprise, 3,750; French Camp, Lostine Valley, 5,500; Lazy T. Ranch, Chief Joseph Mountain, 4,500; Johnson Park, Wallowa River, 2,750; Lostine, 3,360; Lostine Valley, 4,500-5,600; Wallowa Creek, 4,675; Wallowa Lake, 4,410.

Collections of crane-flies were made by us along the inlet of Wallowa Lake in late June 1948. Most of these specimens were taken near the spring of the Pacific Power and Light Company at the Wallowa Falls Generating Station, and along the trail to Ice Lake in the Eagle Cap Wilderness Area, Wallowa National Forest. From June 30 to July 2, and again between August 18 and 20, 1948, we camped in the beautiful Lostine Valley (Lake Creek and French Camps). Between July 1 and September 10, 1949, John and Grace Sperry were in the Wallows, for virtually all of this time being stationed at the Lazy T Ranch, on Chief Joseph Mountain, near Enterprise. A serious accident after mid-July prevented John Sperry from collecting for the next several weeks but during this period of convalescence, Grace continued the collecting of insects, including Tipulidae. The total collections of the Sperrys have added some fine records to the state list and I am most grateful to them for this continued co-operation in our studies of Western American Tipulidae. On June 28, 1948, Lane, Baker and the writer collected along the trail to Ice Lake and the vicinity of Wallowa Lake, while on July 26, 1949, Baker and Lane collected along the trail to Aneroid Lake to an altitude of more than 7,000 feet. The first crane-flies taken in the Wallows appear to be those collected by Scullen at Aneroid Lake in July 1926 (as recorded under *Prionocera oregonica*).

Collectors and Localities.—A summary of the known collectors of Tipuloidea in Oregon is provided herewith. Throughout the text, specimens taken by Fender are indicated by the letter "F"; those collected by Mrs. Alexander and the writer by the letter "A". The asterisk indicates the more important collectors.

- | | | |
|-------------------------|-----------------------|----------------------|
| Aitken, Thomas H. G. | *Fender, Kenneth Mark | Miller, Leo |
| Albright, Kenneth | Ferguson, George | Morrison, Herbert K. |
| Albright, Ray | Frewing, D. K. | Mote, Don C. |
| Aldrich, John M. | Gardner, R. | Motley, Lee |
| *Alexander Charles P. | Gentner, L. A. | Osborn, Muriel |
| *Alexander, Mabel M. | Gillespie, D. G. | *Post, Richard L. |
| *Baker, James H. | Glover, Frederick | Rieder, R. E. |
| Barber, Don | Gray, K. | Roaf, James |
| Bell, John W. | Hammond, D. | Ross, Marshall |
| Bock, J. F. | Hach, D. W. | Sargent, M. J. |
| Bohart, George | Hill, Laura | Schuh, J. |
| Bowerman, Harold | James, Maurice T. | *Scullen, Herman A. |
| Bruce, R. F. | Kimmey, F. E. | Shattuck, Velma T. |
| Burrill, Alfred C. | Kincaid, Trevor | Shaw, Frank R. |
| Chamberlin, Willard J. | Knowlton, George F. | Shelford, Victor E. |
| *Childs, Leroy | Lanchester, H. P. | Shotwell, A. |
| *Cole, Frank R. | Lane, Merton C. | Sipe, E. P. |
| *Davis, John E. | Larson, N. P. | *Sperry, Grace H. |
| Dice, Lee R. | Lovett, A. L. | *Sperry, John L. |
| Dimmick, R. E. | Macnab, James A. | Taylor, D. |
| *Dirks-Edmunds, Jane C. | Malkin, Borys | Thorne, Harry W. |
| *Dyar, Harrison G. | Maris, Zelna | *Townes, Henry K. |
| Epper, F. | May, Irene I. | Townes, M. |
| *Fender, Dorothy McKey | Melander, Axel L. | Wilcox, J. |

The various stations and localities where crane-flies have been collected in Oregon are listed, together with their county and approximate altitude, where this is known. Many of the altitudes have been taken from the American Guide Series volumes on "Oregon" and "Mount Hood," cited in the References. Certain of the altitudes of places visited by us have been taken or confirmed by altimeter.

- | | |
|---|--|
| Agate Beach, Lincoln Co., 125 ft. | Bear Creek, Siskiyou Nat. For., Josephine Co. |
| Albany, Linn Co., 215 ft. | Bear Springs Forest Camp, Mt. Hood, Wasco Co., 3,200 ft. |
| Albright Ranch, Dayton, Yamhill Co., 160 ft. | Beaver Creek, Mt. Hood, Clackamas Co., 1,150 ft. |
| Alsea, Benton Co., 1,245 ft. | Beech Creek Forest Camp, Malheur Nat. For., Grant Co., 4,500 ft. |
| Amity Hills, Yamhill Co., 500 ft. | Bend, Deschutes Co., 3,550 ft. |
| Aneroid Lake, Wallowas, Wallowa Co., 7,500 ft. | Big Creek, Coos Co. |
| Annie Springs, Crater Lake, Klamath Co., 6,000 ft. | Big Meadow, N. Santiam Highway, Linn Co., 3,460 ft. |
| Antelope Mt., Harney Co., 6,500 ft. | Bly, Klamath Co., 4,355 ft. |
| Anthony Lake, Blue Mts., Baker Co., 7,000 ft. | Bonneville, Multnomah Co., 50 ft. |
| Archer's Camp, Creswell, Lane Co., 535 ft. | Boyer, see Saddle Mt., Lincoln Co. |
| Ashland, Jackson Co., 1,900 ft. | Brookings, Curry Co., 130 ft. |
| Aurora, Marion Co. | Brook Meadow, sw of The Dalles, Wasco Co. |
| Austin, Blue Mts., Grant Co., 4,080 ft. | |
| Baker, Baker Co., 3,440 ft. | Canby, Clackamas Co., 155 ft. |
| Baker Creek Valley, McMinnville, Yamhill Co. | Cannon Beach, Clatsop Co. |
| Bald Mt., Yamhill Co. | Carlton, Willamette Valley, Yamhill Co., 225 ft. |
| Balloon Tree Trail, Blue Mts., Union Co., 5,000 ft. | Cascade Head Expt. For., Siuslaw Nat. For., Tillamook Co. |
| Barlow Pass, Mt. Hood, Clackamas Co., 4,160 ft. | Cascadia, S. Santiam Highway, Linn Co., 800 ft. |
| Bear Creek, Mt. Hood, Clackamas Co., 1,400 ft. | Castlecreek Garden, Crater Lake, Klamath |

- Co., 6,800 ft.
 Castle Rock, Tillamook Co.
 Cave Junction, Josephine Co., 1,350 ft.
 Charleston, Coos Co.
 Chetco R., Curry Co.
 Chief Joseph Mt., Wallowas, Wallowa Co., 4,500 ft.
 Chintimini (Marys Peak), Benton Co., 4,097 ft.
 Chitwood, 270 ft.
 Clackamas Lake, Hood Nat. For., Clackamas Co., 3,300 ft.
 Clear Lake, Hood Nat. For., Wasco Co., 3,300 ft.
 Cloverdale, Tillamook Co., 25 ft.
 Cloud Cap Inn, Mt. Hood, Hood River Co., 5,985 ft.
 Cold Springs For. Camp, Crater Lake, Klamath Co., 5,900 ft.
 Coos Bay, Coos Co., sea-level
 Coquille River, Sitkum, Coos Co.
 Corvallis, Benton Co., 225 ft.
 Crater Lake, Klamath Co., 6,177 ft.
 Creswell, Lane Co., 535 ft.
 Cultus Lake, Deschutes Nat. For., Deschutes Co., 4,670 ft.
- Dayton, Yamhill Co., 160 ft.
 Deer Creek, McMinnville, Yamhill Co.
 Dell Creek, Willamette R., Lane Co.
 Deschutes River Guard Sta., Deschutes Co., 4,635 ft.
 Devils Garden Camp, Century Drive, Deschutes Co.
 Dexter, Lane Co., 990 ft.
 Dixie, Grant Co.
 Dutchflat Trail, Anthony Lake, Baker Co., 7,100-7,850 ft.
 Dutchman's Flat, Century Drive, Deschutes Co., 6,100-6,300 ft.
- Eagle Cap Wilderness Area, Wallowas, Wallowa Co., 5,000 ft.
 Eagle Creek Forest Res., Clackamas Co.
 Eagle Creek For. Camp, Multnomah Co., 300 ft.
 Edmunds Ranch, High Heaven, Yamhill Co., 700 ft.
 Eel Creek For. Camp, Coos Co.
 Elgin, Blue Mts., Union Co., 2,665 ft.
 Elk Creek, Siskiyou Nat. For., Josephine Co., 1,600 ft.
 Elk Lake, Century Drive, Deschutes Co., 4,900 ft.
 Elk Lake, Marion Co., 3,850 ft.
 Enterprise, Wallowas, Wallowa Co., 3,750 ft.
 Eola Hills, Yamhill Co.
 Eugene, Lane Co., 425 ft.
- Faubion, Bear Creek, Mt. Hood, Clackamas Co., 1,400 ft.
- Fern Ridge Reservoir, Lane Co.
 Fish Lake, Steens Mts., Harney Co., 7,000 ft.
 Florence, Lane Co., 10 ft.
 Forest Grove, Washington Co., 195 ft.
 Fort Klamath, Klamath Co., 4,185 ft.
 Fremont Nat. For., Klamath-Lake Cos.
 French Glen, Steens Mts., Harney Co.
- Gales Creek, Wilson R., Washington Co.
 Glenada, Lane Co.
 Gold Beach, Curry Co., 70 ft.
 Grand Ronde, Polk Co., 335 ft.
 Granite, Blue Mts., Grant Co., 5,500 ft.
 Grants Pass, Josephine Co., 950 ft.
 Gunaldo Falls, Sourgrass Creek, Yamhill Co.
- Happy Valley, McMinnville, Yamhill Co.
 Harris Beach State Park, Curry Co., sea-level.
 Hazel Creek, near Dexter, Lane Co., 990 ft.
 Hemlock, Tillamook Co.
 Henderson Bridge, Yamhill Co.
 High Heaven, Yamhill Co.,
 Hillsboro, Washington Co.
 Hood Craven Cabin, Saddle Mt., Lincoln Co., 3,000 ft.
 Hood River, Hood River Co., 155 ft.
 Hood River Meadows, Mt. Hood, Hood River Co., 4,480-4,500 ft.
 Honeyman (Jessie M.) State Park, Lane Co.
 Horseshoe Lake, Blue Mts., 7,500 ft.
 Horsetail Falls, Multnomah Co., 100 ft.
 Horsethief Meadows, Mt. Hood, Hood River Co., 3,400 ft.
 House Rock For. Camp, S. Santiam, Linn Co., 1,600 ft.
 Huckleberry Mt., Crater Lake, Klamath Co., 6,000 ft.
 Humbug Mt. State Park, Curry Co., sea-level.
 Huntington, Baker Co., 2,110 ft.
 Hurricane Creek, Wallowas, Wallowa Co., 5,200-6,000 ft.
- Illinois R., Siskiyou Nat. For., Josephine Co., 950 ft.
 Independence, Polk Co., 170 ft.
 Indian Ford, Deschutes Nat. For., Deschutes Co., 3,240 ft.
- Johnson Park, Wallowa R., Wallowa Co., 2,750 ft.
 Jordan Creek, Wilson R. Highway, Tillamook Co.
 Joseph, Wallowas, Wallowa Co., 4,400 ft.
 Jungle Creek, Odell Lake, Klamath Co., 4,800 ft.

- Juntura, Malheur Co., 2,955 ft.
- Kelly Creek, Wapinitia Cutoff, Wasco Co., 3,200 ft.
- Lake-o-Woods (Lake of the Woods), Klamath Co.
- Lake Trembley, Chitwood, Linn Co., 270 ft.
- Langdon Lake, Blue Mts., Umatilla Co., 4,970 ft.
- Langlois, Curry Co., 90 ft.
- Lazy Creek, Odell Lake, Klamath Co., 4,800 ft.
- Lazy T Ranch, Wallowa, Wallowa Co., 4,500 ft.
- Lee's Camp, Tillamook Co.
- Lime, Burnt Creek, Baker Co., 2,225 ft.
- Little Antone Creek, Blue Mts., Baker Co.
- Little Deschutes R., Deschutes Nat. For., Klamath Co.
- Little Phillips Creek, Blue Mts., Union Co.
- Lost Creek, Crater Lake, Klamath Co.
- Lostine, Wallowa Co., 3,360 ft.
- Lostine Guard Station, Wallowa, Wallowa Co., 4,700 ft.
- Lost Prairie, Willamette Nat. For., Lane Co., 1,150 ft.
- Malheur National Forest, Grant Co.
- Malone Spring For. Camp, Rogue River Nat. For., Klamath Co., 4,150 ft.
- Marion Creek, Linn Co.
- Marshfield, Coos Co.
- Marys Peak, Coast Range, Benton Co., 4,097 ft.
- Marys River, Benton Co.
- McCredie Springs, Lane Co.
- McMinnville, Yamhill Co., 115 ft.
- Meadow Lake, Carlton, Yamhill Co.
- Medford, Jackson Co., 1,375 ft.
- Merrill Creek, N. Santiam Highway, Linn Co.
- Metolius R., Deschutes Nat. For., Jefferson Co., 2,600-3,000 ft.
- Milton, Blue Mts., Umatilla Co., 1,275 ft.
- Minam, Wallowa Co., 2,700 ft.
- Mosquito Creek, Whitney, Baker Co.
- Mossy Rock Forest Camp, Ochocos, Crook Co., 4,000 ft.
- Mount Angel, Marion Co., 165 ft.
- Mount McLoughlin, Jackson Co., 9,493 ft.
- Mountain Creek, Wheeler Co.
- Muddy Valley, McMinnville, Yamhill Co.
- Multnomah Falls, Columbia R., Multnomah Co., 100 ft.
- Neskowin, Tillamook Co., 17 ft.
- O'Brien, Josephine Co., 1,475 ft.
- Ochoco Forest Camp, Ochocos, Crook Co., 4,000 ft.
- Odell Lake, Klamath Co., 4,760-4,790 ft.
- Oneonta Gorge, Columbia R., Multnomah Co., 100 ft.
- Oregon Caves, Josephine Co.
- Oswego, Clackamas Co.
- Pacific City, Tillamook Co.
- Panther Creek, McMinnville, Yamhill Co.
- Peavine Ridge, Yamhill Co., 210-1,085 ft.
- Pedro Mt., Baker Co., 3,500 ft.
- Pendleton, Umatilla Co., 1,070 ft.
- Peoria Ferry, Benton Co.
- Philomath, Benton Co., 280 ft.
- Pine Creek, Baker Co., 4,500 ft.
- Pistol R., Curry Co.
- Polally For. Camp, Mount Hood, Hood River Co., 3,000 ft.
- Pole Creek Meadows, Crater Lake, Klamath Co., 5,850-5,900 ft.
- Pratum, Marion Co.
- Princess Creek For. Camp, Odell L., Klamath Co., 4,760 ft.
- Prospect, Jackson Co., 2,600 ft.
- Redwood Ranger Station, Cave Junction, Josephine Co.
- Rieth, Umatilla Co.
- River Island For. Camp, Metolius R., Jefferson Co., 3,000 ft.
- Rivers Edge For. Camp, near Westfir, Lane Co., 1,000 ft.
- Roaring River Fish Hatchery, Marion Co.
- Robin Hood For. Camp, Mount Hood, Hood River Co., 3,560 ft.
- Rock Creek, Corvallis, Benton Co.
- Rogue River, Jackson Co.
- Roseburg, Douglas Co., 480 ft.
- Saddle Mt. (Boyer Station), Lincoln Co., 1,400 ft.
- Saddle Mountain State Park, Clatsop Co.
- Sahale Falls, Mount Hood, Hood River Co., 4,575 ft.
- Salem, Polk Co., 170 ft.
- Salmon River, near Boyer, Polk Co.
- Salmon River, Mount Hood, Clackamas Co.
- Sand Lake, Tillamook Co.
- Santiam Pass, Deschutes Co., 4,815 ft.
- Salt Creek Falls, Lane Co., 3,800 ft.
- Schweitzer Creek, near Westfir, Lane Co., 1,000 ft.
- Seaside, Clatsop Co., 16 ft.
- Shady Dell For. Camp, Lane Co.
- Sherwood For. Camp, Mount Hood, Hood River Co., 3,100 ft.
- Shevlin Park, Tumalo Creek, Bend, Deschutes Co., 3,610 ft.
- Silver Creek Falls, Marion Co., 800-1,000 ft.

- Siskiyou Mt., Jackson Co.
 Sitkum, Coquille R., Coos Co.
 Sourgrass Creek, Yamhill Co.
 Sparks Lake, Century Drive, Deschutes Co., 5,450 ft.
 Spencers Butte, Eugene, Lane Co.
 Spring Creek, Blue Mts., Baker Co., 3,900 ft.
 Starr Creek, Malheur Nat. Forest.
 State Line Creek, Josephine Co., 1,700 ft.
 Steens Mountains, Harney Co.
 Still Creek, Mount Hood, Clackamas Co., 3,600-3,800 ft.
 Store Gulch For. Camp, Siskiyou, Josephine Co., 1,190 ft.
 Summit, Benton Co., 650-750 ft.
 Summit Lake, Willamette Pass, Lane Co., 5,120 ft.
 Sunshine Shelter, Three Sisters, Deschutes Co., 6,000 ft.
 Tahkenitch Lake, Reedsport, Douglas Co.
 The Dalles, Wasco Co., 95 ft.
 Three Creek Lake, Three Sisters Area, Deschutes Co.
 Three Rivers, Tillamook Co.
 Tierra del Mar, Tillamook Co., sea-level to 50 ft.
 Tilly Jane For. Camp, Mount Hood, Hood River, 5,600 ft.
 Todd Lake, Century Drive, Deschutes Co., 6,100 ft.
 Tollgate, Langdon Lake, Blue Mts., Umatilla Co., 5,000 ft.
 Tombstone Meadows, S. Santiam Highway, Linn Co.
 Trout Creek For. Camp, Willamette Nat. Forest, Linn Co., 1,245 ft.
 Tumalo Creek, Bend, Deschutes Co., 3,610 ft.
 Vale, Malheur Co.
 Vernonia, Columbia Co.
 Vidale Falls, Crater Lake, Klamath Co., 6,500 ft.
 Viento, Hood River Co., 140 ft.
 Wahkeena Falls, Multnomah Co., 100 ft.
 Wallace Bridge, Polk Co., 200 ft.
 Walla Walla R. (Upper), Blue Mts., Umatilla Co., 1,450 ft.
 Wallowa Creek, Wallowa Co., 4,675 ft.
 Wallowa Lake, Wallowa Co., 4,410 ft.
 Wapanitia Cutoff, Mount Hood, Wasco Co.
 Warner Lakes, Lake Co.
 Westfir, Middle Fork Willamette R., Lane Co., 1,000 ft.
 Wheeler, Tillamook Co., 50 ft.
 Whitney, Blue Mts., Baker Co.
 Wildhorse Prairie Lookout, Curry Co.
 Wildwood For. Camp, Ochocos, Crook Co., 4,500 ft.
 Willis Creek, N. Santiam Highway, Linn Co.
 Willowdale, Marion Co., 240 ft.
 Wilson River, Tillamook Co.
 Wood Hop Yard, Willamette R., Yamhill Co.
 Yachats, Lincoln Co., 15 ft.
 Zena, Eola Hills, Yamhill Co.

ACKNOWLEDGEMENTS

The parts of three summers that Mrs. Alexander and I have spent in Oregon have yielded several thousand specimens of crane-flies. The outstanding series of these flies taken at all seasons and over a period of many years by Mr. Kenneth Mark Fender has proved even more important and has added numerous species to the Oregon list. An expression of deepest thanks and appreciation to Mr. Fender seems most inadequate when weighed against the amount of time and labor that he has devoted to the collecting of these flies. Further acknowledgements are made to all other collectors but particularly to those in the preceding list whose names are preceded by an asterisk. Special thanks are extended to Messrs. James H. Baker, Frank R. Cole, John E. Davis, James A. Macnab, Herman A. Scullen, and John L. Sperry, and to Mrs. Grace H. Sperry. I have been privileged to study the collections of the Oregon State Agricultural College, Corvallis, through the kind interest of Professors Don C. Mote and Herman A. Scullen, and of the United States National Museum, through the late Dr. John M. Aldrich and Dr. Alan Stone. And very especially do I express my continued thanks and appreciation to Mrs. Alexander, camp-mate and loyal helper in my studies on the crane-flies.

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Systematic Account

TANYDERIDAE

Protanyderus margarita Alexander, 1948.—Blue Mts.: Upper Walla Walla River, above Milton, 1,275 ft., July 4, 1948 (A); a single specimen swept from vegetation along river. A characteristic Rocky Mountain and Great Basin species.

Protanyderus vipio (Osten Sacken, 1877).—Willamette Valley: Dayton, on gravel bar in Willamette River, April 17, 1949 (*Dorothy McKay-Fender*); South Fork of Marys River, April 25, 1940 (*Fred Glover*); an alcoholic female in Oregon State Agricultural College Collection. Known hitherto only from coastal section of California.

PTYCHOPTERIDAE

Ptychoptera lenis lenis Osten Sacken, 1877.—Coast: Deer Creek, May 6, 1945 (F); Pacific City, May 23, 1948 (F). Willamette Valley: Peavine, Sta. 1, May 2, 1946 (F). Aurora, June 20, 1925 (*Melander*); Dayton, Willamette River, April 24, 1949 (F); Summit, 650 ft., June 8, 1929 (*Scullen*). Southern Oregon: Ashland-Lake of the Woods, June 12, 1945 (F). Cascades: Hood River, June 5 (*Cole*); Mount Hood-Hood River Meadows, 4,480 ft., July 31, 1948 (F), small, approaching the race *coloradensis*; Still Creek, 3,600 ft., July 17, 1947 (A & F).

Ptychoptera lenis coloradensis Alexander, 1937.—Blue Mts.: Spring Creek, 3,900 ft., May 23, 1949 (*Baker*).

Ptychoptera pendula Alexander, 1937.—Blue Mts.: Mosquito Creek, Whitney, June 19, 1949 (*Ilah Baker*). A characteristic Rocky Mountain species.

Ptychoptera sculleni Alexander, 1943.—Coast: Alsea Mt., May 23, 1931 (*Scullen*), types; Bald Mt., July 19, 1942 (F); High Heaven, August 6, 1946 (A & F); Jessie M. Honeyman State Park, August 12, 1948 (F); Salmon River, near Boyer, August 12, 1948 (F). Willamette Valley: Peavine, Sta. 3, July 1, 1947, July 2, 1949; Sta. 3A, September 10-24, 1945, September 13, 1948 (F), Silver Creek Falls, August 2, 1948 (F). Southern Oregon: State Line Creek, 1,700 ft., August 9, 1948 (A & F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (A & F); Bear Springs, 3,200 ft., August 8, 1946 (F); Hood River Meadows, 4,480 ft., July 31, 1948 (A & F); Horsethief Meadows, 3,400 ft., July 18, 1947 (F); Still Creek, 3,600 ft., July 17, 1947, July 31, 1948, (F). Cascadia, August 11, 1924 (*Scullen*), types; Big Meadows, August 3, 1948 (A); Lost Prairie, August 3, 1948 (F); Tombstone Meadows, August 17, 1947 (F & *Albright*); Metolius River, August 3, 1948 (A & F).

Ptychoptera townesi Alexander, 1943.—Coast: Gunaldo Falls, June 30, 1949 (F); High Heaven, June 22, 1945, August 6, 1946, May 4, 1947, July 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, June 4-11, 1946, May 1-22, 1947; Sta. 3, May 14-20, 1947, May 11, 1948 (F), Happy Valley, May 12, 1946 (F); Silver Creek Falls, July 8, 1949 (F & *Davis*). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F); Beaver Creek, 1,150 ft., July 16, 1947 (A & F); Still Creek, 3,600 ft., July 17, 1947 (A & F). Hazel Creek, Willamette River, 990 ft., July 15, 1947 (A).

Bitacomorphella fenderiana Alexander, 1947.—Willamette Valley: Peavine, Sta. 1, May 24, 1947; Sta. 3A, May 15, 1946, type; May 5-26, 1945, August 22, September 17, 1946, type material; May 5-19, 1947, May 12-24, September 9-13, 1948, July 9, 1946; Sta. 3, August 22, 1946, June 29, 1948 (F). Albrights, Dayton, September 19, 1946 (F), type material. Cascades: Mount Hood-Bear Springs, 3,200 ft., August 8-9, 1946 (A & F); Hood River Meadows, 4,480 ft., July 31, 1948 (A & F); Horsethief

Meadows, 3,400 ft., July 18, 1947 (A); Robin Hood Camp, 3,560 ft., July 18, 1947 (F); stream below timberline, 5,000 ft., August, 7, 1946 (A); Wapinitia cutoff, August 7, 1946 (F).

Bitacomorphella sackeni (Röder, 1890).—Coast: Alsea Mt., May 26, 1934 (Scullen). Willamette Valley: Peavine, Sta. 3, August 22, 1946, July 2, 1949; Sta. 3A, May 26-June 5, 1945, May 15-June, October 12, 1946, May 5, 1947, June 8, 1948 (F). Albrights, Dayton, September 19, 1946 (F). Cascades: Mount Hood—At 3,000 ft., July 29, 1921 (Melander). Cascadia, August 12, 1924 (Scullen); Hazel Creek, 990 ft., July 15, 1947 (A).

Bitacomorpha occidentalis Aldrich, 1895.—Coast: Saddle Mt. (Boyer), September 1, 1937 (Macnab). Cascades: Mount Hood-Bear Creek, 1,400 ft., July 16, 1947 (A); Horsethief Meadows, 3,400 ft., August 9, 1946, July 18, 1947 (A & F). Hood River, June 3, 1917 (Cole); Cascadia, August 12, 1924, June 30, 1939 (Scullen); Salt Creek Falls, July 14, 1947 (A); Metolius River, August 3, 1948 (A & F). Crater Lake-Pole Creek Meadows, 5,900 ft., August 3, 1946 (A).

ANISOPODIDAE

Anisopus alternatus (Say, 1823).—Willamette Valley: Corvallis, May 25; Albany, May 2; Forest Grove, April 20 (Cole).

TRICHO CERIDAE

(There has been much confusion in the use of family names in Biology where the type genus of the family terminates in forms such as *-cera*, *-cerus*, *-ceros*, and the like. Thus certain authors use the name Trichoceridae for the present group, while others use Trichoceratidae. The case was submitted to Dr. L. W. Grensted, of Oxford University, distinguished Greek scholar and entomologist, for his opinion, which has now been published in *Entomologist's Monthly Magazine* 84: 280-281; 1948. From this it appears that Greek words that have been Latinized, as in the present case, and with the ending *-cera*, should be treated as above, and the correct name for the present group is Trichoceridae).

Diazosma subsinuata (Alexander, 1915).—Coast: Harris Beach State Park, August 11, 1948 (F); Wheeler, July 24, 1949 (F). Cascades: Mount Hood-Bear Creek, August 1, 1948 (F); Beaver Creek, July 16, 1947 (A); Clackamas Lake, 3,300 ft., August 8, 1946 (F); Hood River side at 3,000 ft., July 29, 1921 (Melander); Eagle Creek Forest Reservation, July 1, 1917 (Melander). Metolius River, August 3, 1948 (A & F); Prospect, May 27, 1921 (Dyar). Crater Lake-Annie Springs, 6,000 ft., August 1, 1946; Pole Creek Meadows, 5,900 ft., August 3, 1946 (A). Blue Mts.: Spring Creek, 3,900 ft., June 25, 1948 (A), August 29, 1948 (Baker). Wallows: Lostine Valley, 5,500 ft., August 19, 1948 (A).

Paracladura trichoptera (Osten Sacken, 1877).—Coast: Agate Beach, March 27, 1949 (F); Boyer, May 9, 1949 (F); Castle Rock, March 31, 1949 (F); Gales Creek, September 5, 1948 (F); High Heaven, May 4, 1947 (F); Edmunds Ranch, April 14, 1949 (F); Gunaldo Falls, June 30, 1949 (F); Hemlock, April 5, 1949 (F); Jordan Creek, September 5, 1948 (F); Lake Tahkenitch, August 12, 1948 (F); Sourgrass Creek, May 17, 1948 (F); Tierra del Mar, May 13, 1949 (F); Wallace Bridge, March 14, 1946 (F). Willamette Valley: Peavine, Sta. 1, October 3, 1945, April 15, 1946, May 22, 1947; Sta. 3, November 8, 1945, March 4-April 26, 1946; Sta. 3A, April 17-May 3, October 1-12, 1946, May 5-19, 1947, April 27, August 30, September 13, 1948 (F). Forest Grove, December, January, February (Cole); Silver Creek Falls, May 9, 1948 (F).

Trichocera annulata Meigen, 1818.—Coast: Peavine, without station, October 10, 1945; October 21, 1946 (F). A European species, widespread throughout the World, in cases, at least, through commerce.

Trichocera colei Alexander, 1919.—Coast: Agate Beach, March 27, 1949; Sand Lake, April 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, February 2, 1947; Sta. 3, October 10, November 8, 1945, February 12, March 9, April 4, 1946, March 12, 1947 (F). Forest Grove, November 11, March 20-26 (Cole), types; Hillsboro, April 1 (Cole), types.

Trichocera columbiana Alexander, 1927.—Willamette Valley: Peavine, Sta. 4, March 18, 1947 (F). There are undoubtedly further records of this species among undetermined materials.

Trichocera garretti Alexander, 1927.—Blue Mts.: Spring Creek, 3,900 ft., April 24-May 9, 1949 (Baker).

Trichocera hyaloptera Alexander, 1949.—Coast: Saddle Mt. (Boyer), February 3, 1935 (Dirks-Edmunds). Willamette Valley: Peavine, Sta. 3, March 4, 1946 (F), types. Happy Valley, April 14, 1946 (F).

Trichocera pallens sp. nov.—Generally similar to *gracilis*, differing in the reddish brown coloration of the thorax and the pale wing veins; male hypopygium with the dististyle relatively short, with a small basal hairy tubercle.

♂. Length, about 4.5-5 mm.; wing, 5.5-5.5 mm.

♀. Length, about 5.5-5.5 mm.; wing, 4.5-5.5 mm.

Very closely allied to *gracilis* Walker, 1848, now generally believed to be identical with the European *saltator* (Harris, 1782), differing in the characters listed in the diagnosis. Mesonotum reddish brown, the praescutum somewhat darker brown. Pleura more yellowed. Legs brown. Wings grayish subhyaline, the veins darker, slightly more delicate than in *gracilis*. Abdominal tergites brown, the sternites paler. Male hypopygium with the dististyle relatively short, at base on mesal face with a small hairy tubercle. Mesal lobes of basistyle broadly meeting but not fused at the midline; gonapophyses long and slender. In *gracilis*, the coloration of the body is dark brown to brownish black. Male hypopygium with the tubercle of the dististyle longer and more slender.

Holotype, ♂, Saddle Mountain (Boyer), Oregon, September 26, 1936 (J. A. Macnab, No. 64). *Allotopotype*, ♀, November 14, 1936. *Paratopotypes*, several ♂ ♀, September 29-December 30, 1934; October 6-November 24, 1935; September 10-November 30, 1936; January, February, October, November, December, 1937 (Macnab and associates). *Paratype*, ♂, Carlton-Meadowlake Road, Yamhill Co., October 13, 1945 (Fender).

Trichocera setosivena Alexander, 1927.—Coast: Agate Beach, March 27, 1949 (F); Castle Rock, March 31, May 13, 1949 (F); Gales Creek, September 5, 1948 (F); Humbug Mountain State Park, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Lake Tahkenitch, August 12, 1948 (F); Saddle Mt. (Boyer), December 2, 1933, November 10-December 30, 1934, January 5, 1935, October 25, 1936, February 6, October 30, 1937 (J. A. Macnab and associates); South Fork of Chetco River, March 18, 1940 (Post & Ross). Willamette Valley: Peavine, Sta. 3, May 6, 1945, February 12, March 21, April 26, September 13, 1946, May 7, 1947 (F). Silver Creek Falls, August 1-2, 1948 (A). Cascades: Mount Hood-Salmon River, July 30, 1948 (F); Horsetail Falls, August 9, 1946 (A); Oneonta Gorge, July 19, 1947 (A).

TIPULIDAE

TIPULINAE

Phoroctenia vittata angustipennis (Loew, 1872) (*Malpighia* Enderlein).—Willamette Valley: Peavine, Sta. 1, April 23, May 18, June 21, 1946, May 1-22, 1947, Sta. 2, April 26, May 21, 1947; Sta. 3A, May 29-June 10, 1945; Sta. 4, June 12, 1946 (F). Corvallis, April, May, to October 29 (Lovett); Spencer's Butte, Eugene, April 20, May 25, 1947 (Malkin), reared. Cascades: Mount Hood-Hood River, May 21, 1929 (D. G. Gillespie); Tilly Jane Creek, 5,600 ft., July 18, 1947 (M. M. Alexander).

Lovett (1915) discusses damage to prune trees in Oregon caused by the larvae of this species, the chief damage resulting from rains entering the trees through the larval tunnels.

Holorusia (Holorusia) grandis Bergroth, 1888 (*rubiginosa* Loew, 1863; preoccupied by *rubiginosa* Bigot, 1863).—Willamette Valley: Corvallis, June 10-11, 1922 (Lovett); Eugene, June-July 1946 (Malkin); McMinnville, July 15, 1945 (F), June 25, 1946 (Macnab). Southern Oregon: North slope of Siskiyou Summit, June 9, 1947 (F); Store Gulch Forest Camp, Siskiyou National Forest, 1,190 ft., August 8, 1948 (A & F). Cascades: Mount Hood-Hood River, June (Cole); Still Creek, 3,600 ft., July 17, 1947 (F); Horsetail Falls, August 9, 1946 (A & F). Cascadia, August (Cole); House Rock Forest Camp, S. Santiam, 1,600 ft., August 2, 1948 (Macnab). Blue Mts.: Upper Walla Walla River, near Milton, August 17, 1948 (A).

Prionocera oregonica Alexander, 1943.—Willows: Aneroid Lake, 7,500 ft., July 25, 1929 (Scullen); type. In the original description, erroneously indicated as being in the Blue Mountains.

Nephrotoma ferruginea (Fabricius, 1805).—Cascades: Hood River, June 3-15 (Cole); Tumalo Creek, Bend, August 15, 1948 (A). Blue Mts.: Spring Creek, 3,900

ft., June 7, 1949 (Baker); Baker, 3,400 ft., September 12, 1948 (Baker); Dixie, May 18, 1949 (Davis); Rieth, Umatilla River, July 5, 1948 (A). Wallowas: Enterprise, 3,750 ft., July 28, 1929 (Scullen); Lazy T Ranch, July 14, 1949 (Sperry); French Camp, Lostine Valley, 5,300 ft., July 8, 1949 (Sperry).

Nephrotoma lugens erythrophrys (Williston, 1893).—Blue Mts.: Anthony Lake, 7,100 ft., August 9, 1929 (Scullen); Dutchflat Trail, Anthony Lake, 7,100-7,850 ft., August 8, 1929 (Scullen); North Powder River, 3,800 ft., June 27, 1928 (A); Spring Creek, 3,900 ft., July 31, 1949 (Baker). Wallowas: Joseph (Cole auct.). Steen Mts.: Fish Lake, 7,000 ft., June 25, 1922 (W. J. Chamberlin).

Nephrotoma occidentalis (Doane, 1908).—Coast: Neskowin, August 13, 1948 (James); Tillamook, September 19-21, 1949 (Davis).

Tipula (Bellardina) aspersa Doane, 1912.—Coast: Marshfield, September 14, 1934 (Melander); Neskowin, August 13-19, 1948 (James). Willamette Valley: Peavine, Sta. 3, September 13, 1946, September 3, 1947, September 11, 1948; Sta. 3A, September 10-18, 1945, September 17-October 1, 1946, September 13, 1948 (F). Albrights, Dayton, September 19, 1946 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F); Beaver Creek, 1,150 ft., August 7, 1946 (A & F); below timberline, 5,100 ft., August 7, 1946 (A & F). Metolius River, August 3, 1948 (A & F); Salt Creek Falls, 3,800 ft., August 7, 1948 (A & F); Willis Creek, N. Santiam, August 17, 1947 (F).

A characteristic late season inhabitant of the alder-skunk cabbage association.

Tipula (Bellardina) gothicana Alexander, 1943.—Willamette Valley: Silver Creek Falls, on wet cliff near falls, 950 ft., August 2, 1948 (A & F). Cascades: Mount Hood, altitude 3,000 ft., July 29, 1921 (Melander). Blue Mts.: Spring Creek, 3,900 ft., June 26, 1948 (A); Pine Creek, 4,400 ft., June 25, 1948 (A & Baker).

Tipula (Bellardina) jepsoni Alexander, 1945.—Wallowas: Wallowa Lake, July 14, 1947 (Davis); 2 small males.

***Tipula (Bellardina) josephus* sp. nov.**—Generally similar to *commiscibilis* Doane, 1912 (Alberta, Wyoming, Colorado, Utah, New Mexico), differing conspicuously in the structure of the male hypopygium.

♂. Length, about 20-21 mm.; wing, 20-22 mm.

♀. Length, about 22-25 mm.; wing 19-23 mm.

Praescutum buffy, the dark gray stripes bordered by dark brown, the lateral margins broadly darkened; scutal lobes with the entire centers dark brown; a narrow brown central line on scutellum and mediotergite. Abdomen chiefly light reddish brown, vaguely patterned with darker.

Male hypopygium having the essential characters of *commiscibilis*, that is, with the ninth tergite transverse, the median area broadly membranous, the long narrow lateral lobes provided with dense black setae. Outer dististyle a large scoop-like structure, the whitened outer face with few setae, the concave inner face with abundant long black setae; inner dististyle relatively small and inconspicuous.

In *commiscibilis*.—Ninth tergite with the blackened setae abundant but short. Outer dististyle with a sclerotized basal plate that terminates in a strong spine or hook, directed laterad; outer end of style extended into a short horny point. Inner dististyle a long slender rod, its base dilated and provided with long setae. Aedeagus a simple rod, without a basal projection.

In *josephus*.—Ninth tergite with the blackened setae denser and much longer. Outer dististyle without the sclerotized basal armature. Inner dististyle relatively small and stout, the outer half slightly more narrowed than the base. Aedeagus with a powerful bispinuous lobe at base of lower margin.

Ovipositor of *josephus* with the cerci black, the acute tips paler. In *commiscibilis*, the cerci pale brown, the tips narrowly obtuse.

Holotype, ♂, Lee Motley Ranch, Durkee, August 28-30, 1940 (Lee Motley & R. L. Post); type in Oregon State Agricultural College. **Allotopotype**, ♀. **Para-topotypes**, a few ♂ ♀, with the types.

The species is named for Chief Joseph the younger, leader of the Nez Perce Indian war of 1877. The 1,400 mile retreat of the great chief and his people is one of the outstanding events in American history. Joseph died in 1904 and is buried at Nespelem, Washington, on the Colville Indian Reservation.

Tipula (Bellardina) pacifica Doane, 1912.—Coast: Alsea Mt., May 23, 1931 (Scullen); Brookings, July 9, 1925 (Scullen); Gualdo Falls, June 6, 1949 (F); Yachats, May 30, 1949 (Davis). Cascades: Mount Hood-Bear Creek, 1,400 ft., August

1, 1948 (A); North fork of Iron Creek, July 30, 1948 (F); Salmon River, July 30, 1948 (F). Odell Lake, 4,760 ft., August 6, 1948, in spider's web (A).

Tipula (*Bellardina*) *rastristyla* Alexander, 1945.—Coast: Gualdo Falls, Sourgrass Creek, April 27, 1949 (F). Hitherto only from Snoqualmie Falls, Washington.

Tipula (*Bellardina*) *subcinerea* Doane, 1901.—Blue Mts.: Spring Creek, 3,900 ft., May 30, 1948, May 8-9, 1949 (Baker). Wallowas: Wallowa Creek, 4,635 ft., June 28, 1948 (M. M. Alexander).

Tipula (*Schummelia*) *subtenuicornis* Doane, 1901.—Coast: Gualdo Falls, July 14, 1949 (F). Willamette Valley: McMinnville, July 16, 1933 (*Macnab*); Silver Creek Falls, July 8, 1949 (F & Davis). Cascades: Mount Hood-Clear Lake, 3,300 ft., August 8, 1946 (F); Horsethief Meadows, 3,400 ft., July 18, 1947 (A); Still Creek, 3,600 ft., July 16-17, 1947, July 31, 1948 (A & F). Big Meadows, August 3, 1948 (A & F); N. Santiam Highway, May 30, 1949 (F); Lost Prairie, 3,700 ft., August 3, 1948 (A & F); Metolius Spring, August 4, 1948 (A & F); Odell Lake, 4,760 ft., August 6, 1948, resting on tree trunks (A); Salt Creek Falls, 3,800 ft., July 14, 1947, August 7, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A), June 5-15, 1949 (Baker). Wallowas: Wallowa Lake, 4,410 ft., June 28, 1948 (A).

Tipula (*Tipula*) *carinata* Doane, 1901.—Willamette Valley: Corvallis, October 26-November 21 (Cole auct.); McMinnville, October 20, 1942, at light (*Macnab*), October 15-28, 1945, at light (F).

Tipula (*Tipula*) *spenceriana* Alexander, 1943.—Blue Mts.: Spring Creek, 3,900 ft., August 29-September 19, 1948 (Baker); La Grande, September 11, 1948 (Davis).

Tipula (*Yamatotipula*) *cognata* Doane, 1901.—Cascades: Odell Lake, Princess Creek Forest Camp, 4,760 ft., August 6, 1948 (A); resting on tree trunks. Lobes of ninth tergite of male hypopygium somewhat longer and more slender than in other material determined as being this species but agreeing in other regards. Wallowas: Wallowa Lake, 4,410 ft., June 29, 1948 (A).

Tipula (*Yamatotipula*) *colteri* Alexander, 1943.—Blue Mts.: Spring Creek, 3,900 ft., April 8, 1949 (Baker); Tollgate, Langdon Lake, June 8, 1949 (Baker & Lane).

Tipula (*Yamatotipula*) *continentalis* Alexander, 1941.—Coast: Gualdo Falls, Sourgrass Creek, April 27, May 13, 1949 (F); High Heaven, May 4, 1947 (F); Marys Peak, June 1, 1946 (F). Willamette Valley: Silver Creek, 950 ft., August 2, 1948 (A), July 8, 1949 (F). Southern Oregon: Ashland-Lake of the Woods, July 10, 1945 (F). Cascades: Mount Hood-Stream below timberline, 5,000 ft., July 16, 1947 (A); Sahale Falls, 4,575 ft., July 17, 1947 (A & F); Tilly Jane Creek, 5,600 ft., July 30, 1948, ovipositing in wet earth at stream margin (*Macnab*). Salt Creek Falls, 3,800 ft., July 14, 1947 (M. M. Alexander); Sunshine Shelter, Three Sisters, 6,000 ft., July 12, 1936 (R. E. Rieder). Crater Lake-Pole Creek Meadows, 5,900 ft., August 7, 1948 (A). Wallowas: Aneroid Lake trail, 7,000 ft., July 26, 1949 (Baker).

Tipula (*Yamatotipula*) *edmundsi* Alexander, 1948.—Willamette Valley: Peavine, Sta. 1, April 23, 1946, April 12, 1947 (F). Happy Valley, April 14, 1946 (F). Blue Mts.: Spring Creek, 3,900 ft., April 26-May 9, 1949 (Baker).

Tipula (*Yamatotipula*) near *fulvilineata* Doane, 1912 (*graphica* Doane, 1901).—Coast: Wallace Bridge, May 25, 1947 (Davis); a single female, the male sex needed for full identification.

Tipula (*Yamatotipula*) *spernax spernax* Osten Sacken, 1877.—Willamette Valley: Peavine, Sta. 2, April 16, 1947; Sta. 3, May 2-14, 1945, May 16, 1946 (F). Corvallis, May 8, 1929 (V. T. Shattuck); April 19, May 5 (Cole auct.); Happy Valley, April 14, 1946 (F); McMinnville, April 18, 1947 (F). Southern Oregon: O'Brien, August 9, 1948 (A & F); Ashland-Lake of the Woods, June 10, 1945 (F). Cascades: Prospect, May 23, 1921 (Dyar). Crater Lake-Huckleberry Mt., 6,000 ft., July 15, 1927 (E. P. Sipe). Blue Mts.: Spring Creek, 3,900 ft., May 9, 1949 (Baker).

Tipula (*Yamatotipula*) *spernax lanei* Alexander, 1940.—Cascades: Mount Hood-Hood River Meadows, 4,475 ft., July 31, 1948 (A).

Tipula (*Trichotipula*) *dorsolineata* Doane, 1901.—Wallowas: Enterprise, August 16, 1949 (G. H. Sperry); Lazy T Ranch, 4,500 ft., August 24, 1949 (Muriel Osborn).

Tipula (*Trichotipula*) *macrophallus* (Dietz, 1918).—Coast: High Heaven, June 7-22, 1945, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F). Willamette Valley: Peavine, Sta. 1, July 18, 1946; Sta. 3, July 12, 1945, August 13, 1946 (F). Forest Grove, July 8 (Cole); Happy Valley, August 6, 1946 (F); McMinnville, August 1943 (*Macnab*), July 10-12, 1946, June 30, 1948 (F). Southern Oregon: Store Gulch Forest Camp, Sis-

kiyou National Forest, August 8, 1948 (A & F). Cascades: Mount Hood-Eagle Creek, July 18-19, 1947 (A & F), abundant at lights; Oneonta Gorge, August 9, 1946 (A & F). Bend, August 5-15, 1948 (A); Metolius River, August 3, 1948 (A & F); Indian Ford, 3,240 ft., August 5, 1948 (A & F). Blue Mts.: Spring Creek, 3,900 ft., August 18-29, September 26, 1948 (Baker); Pendleton, July 5, 1948 (A); South fork of Upper Walla Walla River, 1,450 ft., July 4, 1948 (A). Wallows: Johnson Park, Wallowa River, August 20, 1948 (A).

Tipula (Trichotipula) repulsa Alexander, 1943.—Coast: Gales Creek, Wilson River, September 5, 1948 (F). Willamette Valley: Peavine, Sta. 3A, September 9, 1948 (F).

Tipula (Trichotipula) rusticola Doane, 1912.—Coast: High Heaven, August 6, 1946 (A & F). Cascades: Mount Hood-Hood River side, at 3,000 ft., July 29, 1921 (Melander); Hood River Meadows, 4,500 ft., July 31, 1948 (F). Trout Creek Forest Camp, 1,245 ft., August 2, 1948 (F).

Tipula (Arctotipula) bakeriana sp. nov.—Size large (wing over 18 mm.); mesonotal praescutum with the ground color yellow, gray on the sides, with four conspicuous brownish black stripes, the intermediate pair separated by a capillary ground line; setae of notum small and inconspicuous; pleura and pleurotergite gray, the dorsopleural membrane orange-yellow; legs with tips of femora and tibiae broadly blackened; wings pale yellow, the prearcular and costal fields more saturated; stigma dark brown; certain of the veins seamed with brown, more conspicuous beyond the cord, especially in the outer radial field; veins glabrous; *Rs* about twice *m-cu*; abdomen brown to reddish brown, the tergites with a nearly continuous dark brown central stripe, the lateral tergal borders paler; male hypopygium with the tergite produced into two slender spines; outer dististyle relatively narrow, more than twice as long as broad; inner dististyle complex, the outer basal lobe a long slender spine.

♂. Length, about 17-18 mm.; wing, 19-20 mm.; antenna about 3 mm.

♀. Length, about 19 mm.; wing, 20 mm.

Frontal prolongation of head gray, narrowly orange on sides at apex; nasus elongate; palpi black. Antennae relatively short, black, scape gray pruinose; flagellar segments short, narrowed outwardly, the basal enlargements scarcely indicated; segments subequal in length to the verticils. Head gray, clearer gray adjoining the eyes; vertex with a narrow black median stripe, slightly widened behind; vertical tubercle very low to scarcely apparent; surface of head with short black setae, more abundant on genae.

Pronotum gray, narrowly darkened medially. Mesonotal praescutum with the ground yellow, gray on the sides, with four conspicuous brownish black stripes, the intermediate pair separated by a capillary ground vitta that does not reach the suture behind; scutum more obscure brownish yellow, each lobe with two dark areas, the more anterior one smaller but more intense; scutellum gray, infuscated medially; postnotum gray; medio-tergite with the central portion vaguely more darkened; setae of mesonotum small and inconspicuous. Pleura and pleurotergite gray, the dorsopleural membrane orange-yellow; pleura nearly glabrous. Halteres with stem obscure yellow, brighter at base, the knob dark brown. Legs with coxae gray pruinose, with long pale setae; trochanters gray; femora brownish yellow basally, with approximately the outer half blackened; tibiae and basitarsi brown, passing into black at tips, remainder of tarsi black; claws (male) weakly toothed. Wings pale yellow, the prearcular and costal fields more saturated; stigma dark brown, more yellowed at proximal end; most veins seamed with darker, more conspicuous beyond the cord, especially in the outer radial field and along veins *Cu* and *m-cu*; veins brown, paler in the brightened portions, especially the prearcular field. Veins glabrous, even *R*₄₊₅ with scarcely any trichia. Venation: *Rs* about twice *m-cu*, nearly straight; *R*₁₊₂ entire; *m* longer than the petiole of cell *M*₁; *m-cu* at or close to fork of *M*₃₊₄.

Abdominal tergites brown to reddish brown, the basal segment gray pruinose; a conspicuous dark brown central stripe, not or scarcely interrupted at the posterior borders of segments; lateral tergal borders paler; outer segments, including hypopygium, more extensively darkened; ninth tergite of male hypopygium black, the styli fulvous; sternites chiefly reddish gray, with a broken dark brown central stripe, the areas appearing as elongate triangles that are widened behind. Male hypopygium (Fig. 1) with the ninth tergite, 9t, relatively small, broadest at near midlength, thence gradually narrowed; posterior border produced into two long slender glabrous spines that are slightly decurved, the emargination between them U-shaped; surface of tergite with abundant dense black setae. Outer dististyle relatively narrow, more than twice as long as broad, obtuse at tip, the surface with scattered black setae. Inner dististyle, *id*, complex, the main blade or beak broadest,

with a smaller lobule on outer margin; behind the base of this blade with a second more slender rod-like structure that narrows to a point, the outer margin before apex with a spur-like point, the inner margin densely fimbriate; outer basal lobe a long slender spine that narrows gradually to an acute point. Aedeagus black, pale at tip, subtended by small, weakly spatulate gonapophyses, g. Eighth sternite unarmed. Ovipositor with cerci nearly straight, compressed-flattened, the tips obtuse; hypovalvae very short, subtriangular in lateral outline.

Holotype, ♂, Spring Creek, Blue Mountains, 3,900 ft., April 10, 1949 (J. H. Baker). *Allotopotype*, ♀, pinned with type. *Paratopotypes*, 3 ♂♂, with the types; 5 ♂♀, April 24-May 9, 1949 (J. H. Baker).

I take great pleasure in naming this fine species for Mr. James H. Baker, whose cooperation in making known the crane-flies of eastern Oregon has been greatly appreciated. Among the other regional members of the subgenus the fly is most similar to *Tipula* (*Arctotipula*) *semidea* Alexander, differing in all details of structure of the male hypopygium and in other characters.

Tipula (*Arctotipula*) *illustris* Doane, 1901 (*Prionocera fuscipennis* Loew, 1865, pre-

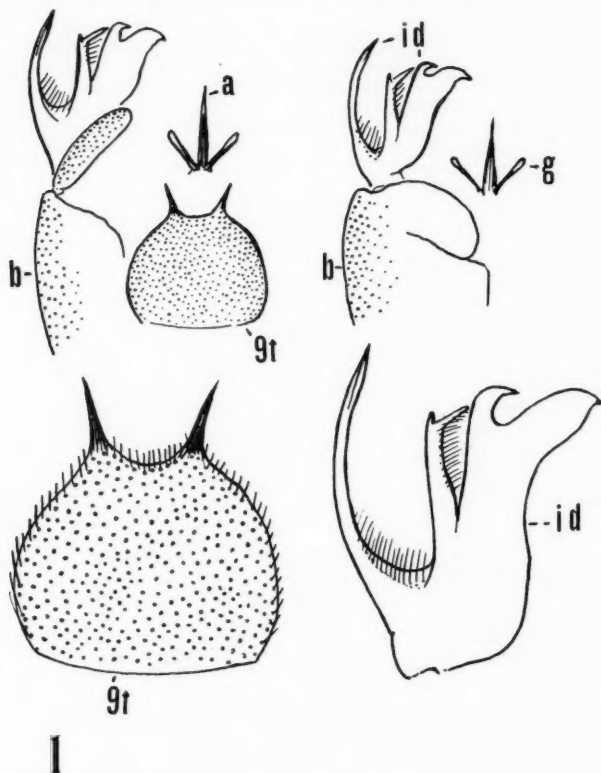


Fig. 1.—*Tipula* (*Arctotipula*) *bakeriana* sp. nov., male hypopygium.

SYMBOLS: a—aedeagus, b—basistyle, d—dististyle, g—gonapophysis, i—interbase, id—inner dististyle, od—outer dististyle, p—phallosome, s—sternite, t—tergite, vd—ventral dististyle.

occupied by *Tipula fuscipennis* Curtis, 1834).—Willamette Valley: Jenkins Lake, March 29, 1939 (F. E. Kimmey). Steens Mts.: French Glen, June 12, 1947 (F).

Tipula (Arctotipula) plutonis Alexander, 1919 (*absaroka* Alexander, 1943).—Southern Oregon: Ashland-Lake of the Woods, June 10, 1945, August 8, 1948 (F). Cascades: Mount Hood-Bear Springs, 3,200 ft., June 15, 1946 (A & F); Hood River Meadows, 4,500 ft., June 12, 1941 (Lane), July 31, 1948 (A & F). Dutchman's Flat, Century Drive, 6,100 ft., August 5, 1948 (A & F); Metolius River, June 15, 1947 (F). Crater Lake-Castlecrest Garden, 6,800 ft., July 12, 1947 (A); Pole Creek Meadows, 5,900 ft., August 3, 1946 (A). Blue Mts.: Anthony Lake, 7,000 ft., June 12, 1939 (Lane & Lanchester), June 27, 1948 (A & Baker); Granite, 5,500 ft., June 21, 1945 (Lane); Langdon Lake, 4,970 ft., July 2-4, 1948 (A), July 17, 1948 (Lane), June 8, 1949 (Baker & Lane); Mottet Ranger Station, June 29, 1939 (Lanchester).

Tipula (Arctotipula) semidea Alexander, 1944.—Willamette Valley: Silver Creek Falls, May 17, 1939 (Scullen); type. The male hypopygium (Fig. 2) is shown. Ninth tergite, 9t, relatively small, depressed; caudal margin with a broad and deep U-shaped

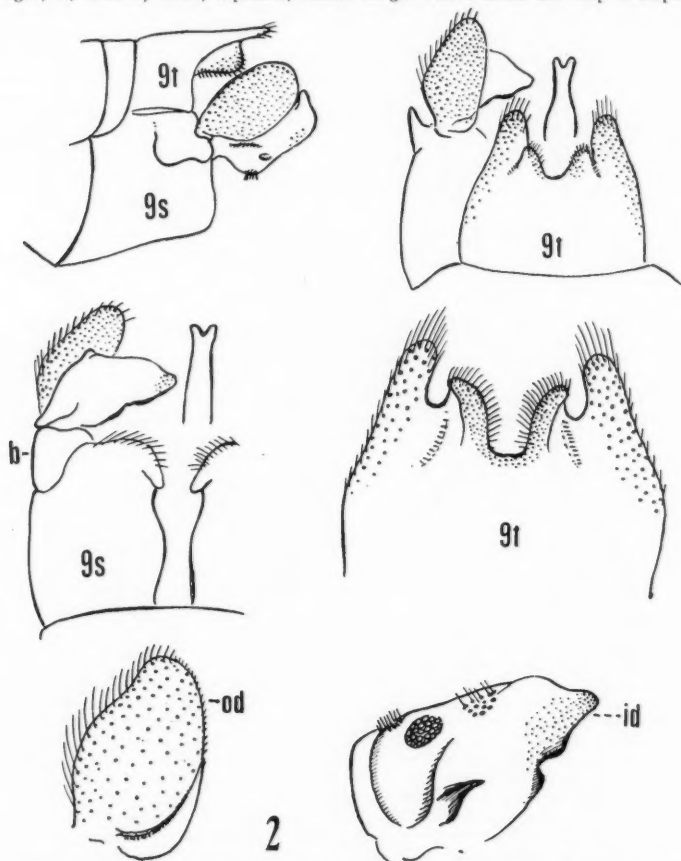


Fig. 2.—*Tipula (Arctotipula) semidea* Alexander, male hypopygium (See fig. 1 for explanation of symbols).

notch, the yellow lateral lobes thin, depressed-flattened, their tips obtusely rounded, provided with conspicuous yellow setae; ventrad of each lateral lobe with a shorter and broader compressed dark-colored blade or lobe, lying more nearly vertically, covered with abundant setae. Outer dististyle, *od*, broadly flattened, its greatest breadth about one-half the length. Inner dististyle, *id*, very simple in structure, with a small blackened tooth at base, the apex of beak obtuse. The hypopygium is shown from lateral, dorsal and ventral aspects.

Tipula (Vestiplex) leucophaea Doane, 1901.—Blue Mts.: Anthony Lake, 7,100-8,650 ft., August 3-4, 1929 (Scullen); Oregon State Agricultural College.

Tipula (Oreomyza) alia Doane, 1911 (*olia* erroneously).—Coast: High Heaven, June 22, 1945 (F); Salmon River, near Boyer, August 12, 1948 (F). Willamette Valley: Peavine, Sta. 1, July 26, 1946; Sta. 3, July 11, 1945, June 26-July 21, 1946 (F). Cascades: Mount Hood-Horsetail Falls, August 9, 1946 (A). Fort Klamath, June 25, 1939 (Aitken).

Tipula (Oreomyza) appendiculata Loew, 1863 (*derelicta* Dietz, 1914; *gaspensis* Alexander, 1929; *stalactoides* Doane, 1901).—Blue Mts.: Spring Creek, 3,900 ft., June 5, 1949 (Baker).

***Tipula (Oreomyza) dorothea* sp. nov.**—Belongs to the *borealis* (*unca*) group; general coloration of mesonotum light gray, the praescutum with a pair of brown intermediate stripes and \cap -shaped lateral ones; scutellum with a median dark vitta; mediotergite with a pair of dark spots on disk; pleura gray, yellowed posteriorly, with a short brown stripe on the dorsal pleurites; antennae (male) elongate, black, the scape and pedicel light yellow; femora and tibiae obscure yellow, the tips narrowly blackened; wings whitish subhyaline, conspicuously patterned with pale brown and darker brown; abdominal tergites with the lateral and caudal margins broadly yellow, the disk with three dark brown stripes; hypopygium chiefly dark brown; ninth tergite with posterior border on either side produced into an unequally bispinous blackened structure; beak of inner dististyle slender, slightly upcurved; dorsal crest with abundant setae, those nearest beak longer; upper process a flattened obtuse blade; lower process a broad pale blade, triangularly dilated at near midlength, thence narrowed and paling into membrane; gonapophysis long and slender, tapering to the very narrow beaklike apex; eighth sternite weakly trilobed, the broad subtruncate median portion with a brush of longer yellow setae.

♂. Length, about 15-16 mm.; wing, 14-16 mm.; antenna about 6.5-7 mm.

♀. Length, about 17 mm.; wing, 17 mm.

Frontal prolongation of head light brown on sides, narrowly light gray above; nasus elongate; palpi with basal two segments dark brown, the remainder paler. Antennae (male) elongate, as shown by the measurements; scape and pedicel light yellow, flagellum black; basal enlargements of segments small, verticils much shorter than the segments. Head light gray, the vertex with three brown spots, the median one linear.

Pronotum gray, with three brown areas. Mesonotal praescutum light gray, with a pair of brown intermediate stripes and \cap -shaped lateral lines that enclose darker gray centers; posterior sclerites of notum gray, the scutal lobes each with two brown areas, the more posterior one more circular; scutellum with a median vitta; mediotergite with a pair of dark spots on disk, the posterior border with two further confluent darkened areas; pleurotergite weakly pruinose, the katapleurotergite more infuscated on its margins. Pleura with the mesepisternum gray, the sternopleurite darker ventrally, the metepimeron and metapleura pale yellow; a brown stripe on dorsal pleurites, extending from the cervical region across the propleura and anepisternum to about midwidth of the latter; dorso-pleural membrane pale yellow. Halteres with stem yellow, knob infuscated. Legs with the coxae grayish yellow, more or less darkened basally, trochanters yellow; femora and tibiae obscure yellow, the tips narrowly blackened; tarsi yellowish brown, passing into brownish black; claws (male) toothed. Wings whitish subhyaline on disk, the posterior border pale brown; dark pattern heavy and contrasted, including darker areas at arculus, origin of *R*_s and stigma, with somewhat paler brown clouds at one-third the length of cell *R*₁ in outer radial field, and as paired spots on basal half of cell *Cu*₁, the spots alternating with the white ground areas; veins brown, more brownish yellow in the ground areas. Venation: *m* longer than the petiole of cell *M*₁.

Abdominal tergites conspicuously patterned, the lateral and posterior margins broadly yellow, the disk more brownish yellow with three dark brown stripes, the broad central one conspicuously interrupted at the posterior borders; sternites infuscated medially, paler on sides, the posterior borders yellow; hypopygium chiefly dark brown. Male hypopygium (Fig. 3) with the ninth tergite, *9t*, elongate, its posterior border on either side produced

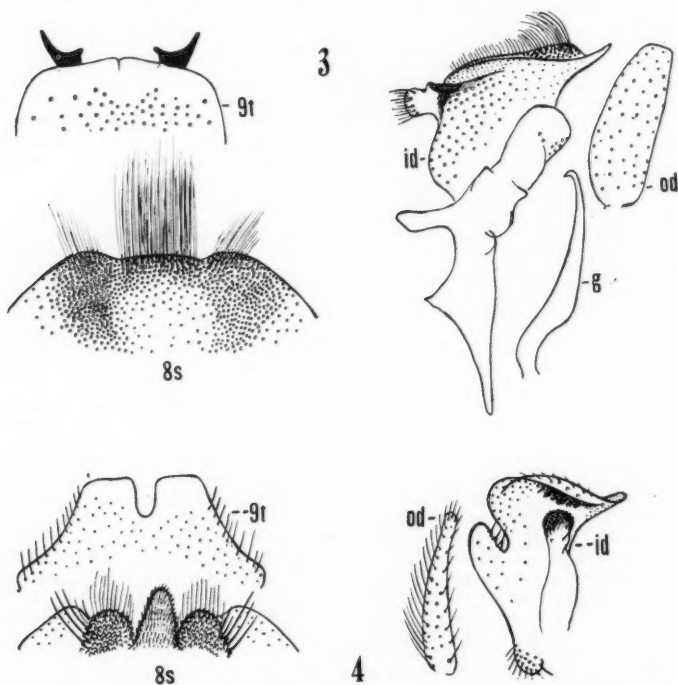
into an unequally bispinous blackened structure. Outer dististyle, *od*, relatively broad, slightly narrowed outwardly, the tip subtruncate. Inner dististyle, *id*, with the beak slender, slightly upcurved; dorsal crest with abundant setae, those nearest beak longer and more bent, the posterior ones shorter but still long and conspicuous; lower process of style a broad blade that gradually widens to beyond midlength where it is more or less triangularly dilated, thence narrowed and paling into hyaline membrane, the membranous portion shorter than the more darkened base; upper process a flattened blade, its apex darkened, obtuse to slightly subacute. Gonapophysis, *g*, long and slender, weakly angulated on basal third, thence very gradually narrowed to the very slender beaklike apex. Eighth sternite, *8s*, with caudal margin weakly trilobed, the wide subtruncated median portion with a brush of long yellow setae, the low lateral lobes with much shorter setae.

Holotype, ♂, Elk Lake, Cascades, 4,900 ft., August 5, 1948 (Fender). *Allotopotype*, ♀. *Paratopotype*, 1 ♂; *paratype*, 1 ♂, Dutchman's Flat, Three Sisters Area, 6,100 ft., August 4, 1948 (Fender).

This interesting crane-fly is named for Mrs. Kenneth M. Fender (Dorothy McKey-Fender), most capable botanist and student of earthworms, who has collected several of the specimens discussed in this report. The nearest allies are *Tipula* (*Oreomyza*) *clathrata* Dietz and *T. (O.) newcomeri* Doane, which differ especially in the structure of the male hypopygia.

Tipula (*Oreomyza*) *fallax* Loew, 1863.—Coast: Salmon River, near Boyer, August 12, 1948 (F). Willamette Valley: Corvallis, April 18-May 9 (Cole auct.).

Tipula (*Oreomyza*) *yellowstonensis* Alexander, 1946.—Cascades: Tumalo Creek,



Figs. 3, 4.—Male hypopygia: 3. *Tipula* (*Oreomyza*) *dorothea* sp. nov.; 4. *T. (O.) bakeri* sp. nov. (See fig. 1 for explanation of symbols).

Bend, 3,610 ft., August 15, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., August 5, 1949 (Baker). Wallows: Johnson Park, Wallowa River, 2,750 ft., August 20, 1948 (A).

Tipula (Oreomyza) accurata Alexander, 1927 (johannus Alexander, 1945).—Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker). Wallows: Lazy T Ranch, 4,500 ft., July 15, 1949 (Sperry).

Tipula (Oreomyza) bakeri sp. nov.—Size small (wing, male, about 11 mm.); general coloration gray, the vertex with a central brown line; praescutum with four narrow entire brown stripes; posterior sclerites of notum with a nearly continuous darkening from the suture to the abdomen; pleura clear gray; femora obscure yellow, the tips vaguely more darkened; wings faintly tinged with gray, the centers of the outer radial cells, particularly R_5 and R_6 , more strongly darkened; stigma darker brown; no squamal setae; R_1 nearly twice as long as R_{2+3} ; R_{1+2} entire; abdominal sternites chiefly brownish black, the tergites and hypopygium yellowed; male hypopygium with the tergite large, entirely pale, its posterior border with a deep and narrow U-shaped notch, the truncated lobes unusually glabrous; basistyle not produced; outer dististyle elongate, with conspicuous setae; eighth sternite only moderately sheathing, the margin with five lobes, the lateral pair low, provided with sparse setae; intermediate pair of lobes appearing as setiferous cushions, with abundant long setae, the outermost four or five longer and stronger; median lobe a tongue-like extension that is densely covered with microscopic setulae.

♂. Length, about 10 mm.; wing, 10-11 mm.; antenna, about 3 mm.

Frontal prolongation of head obscure yellow, nearly as long as remainder of head; nasus long and slender; palpi brown, the terminal segment somewhat darker. Antennae (male) with the long scape yellow; pedicel brown; flagellum brownish black; basal flagellar segment subcylindrical, the succeeding ones with the basal enlargements slightly indicated but the segments only feebly incised; longest verticils a little shorter than the segments. Head light gray, the center of the vertex with a brown line, the sublateral portions of the posterior vertex less distinctly darkened; vertical tubercle very low.

Pronotum gray. Mesonotal praescutum gray, with four narrow entire brown stripes, the intermediate pair narrowly confluent near suture; posterior sclerites of notum light gray, with a nearly entire central darkening extending from the suture to the abdomen; scutal lobes each with two unequal brown areas. Pleura and pleurotergite clear gray; dorsopleural membrane pale yellow. Halteres weakly infuscated, the knob more strongly so. Legs with the coxae light gray; trochanters yellow; femora obscure yellow, the tips very vaguely more darkened; remainder of legs yellow, the terminal tarsal segments dark brown or brownish black; claws (male) toothed. Wings faintly tinged with gray, the centers of the outer radial cells, especially R_5 and R_6 , more strongly darkened; stigma oval, darker brown; veins brown. No stigmal or squamal setae; veins with numerous trichia. Venation: R_1 moderately long, nearly twice R_{2+3} ; R_{1+2} preserved, with trichia on more than the proximal half; cell 1st M_2 narrow; cell M_1 deep, its petiole about one-half m ; cell 2nd A moderately broad.

Abdominal tergites yellowish, the more proximal ones weakly darkened medially; sternites chiefly dark brown or brownish black, the lateral borders broadly more yellowed; hypopygium yellow. Male hypopygium (Fig. 4) with the ninth tergite, $9t$, large, entirely pale, gently narrowed outwardly, the posterior border with a deep and narrow U-shaped notch, the much broader lateral lobes truncated at tips, unusually glabrous, especially near the margins. Appendage of ninth sternites, $9s$, a small setiferous lobule. Basistyle not at all produced, as in *alta*, *mandan* and others. Outer dististyle, od , elongate, pale, with scattered setae over the entire length, the outermost ones shorter. Inner dististyle, id , with the beak blackened, twisted near apex, slender, the lower beak heavily blackened, knoblike, its surface microscopically roughened; outer basal lobe broad, its inner margin with three strong setae from basal tubercles, the most basal one largest. Eighth sternite, $8s$, of distinctive conformation, only moderately sheathing; posterior border with five lobes, the lateral pair relatively short, provided with a few small scattered setae only; inside the lateral pair lie an intermediate set of setiferous cushions, each bearing numerous close-set long pale setae, the outermost four or five much longer and stronger; fifth lobe a median tongue-like appendage that is densely provided with microscopic setulae.

Holotype, ♂, French Forest Camp, Lostine Valley, Wallows, 5,500 ft., August 19, 1948 (Alexander). *Paratypes*, ♂♂, Tumalo Creek, Bend, 3,160 ft., August 15, 1948 (Alexander); Spring Creek, Blue Mts., 3,900 ft., August 29, 1948, July 31, 1949 (Baker); Austin, 4,000 ft., August 10, 1929 (Scullen); Lazy T Ranch, Wallows, 4,500

ft., August 30, 1949 (*Sperry*); Wallowa Lake, 4,500 ft., July 25, 1929 (*Scullen*); Antelope Mt., Steen Mts., 6,500 ft., July 6, 1931 (*D. K. Frewing*).

The species is named for Mr. James H. Baker, to whom much of our knowledge of the crane-flies of the Blue Mts. is due. The fly seems to fall in the group of species containing *Tipula* (*Oreomyza*) *mandan* Alexander and *T. (O.) alta* Doane, differing in hypopygial characters and in all details of coloration. It is likewise quite distinct from *T. (O.) accurata* Alexander, and various related forms.

Tipula (*Oreomyza*) *helicincta* Doane, 1901.—Cascades: Sisters Area—Three Creek Lake road, below Broken Top Mountain, Todd Lake, 6,000 ft., August 3, 1948 (*Macnab*); near Dutchman's Flat, 6,100 ft., August 5, 1948 (*A & F*).

Tipula (*Oreomyza*) *mandan* Alexander, 1915 (*perexigua* Alexander, 1924).—Blue Mts.: Spring Creek, 3,900 ft., June 24-27, 1948 (*A & Baker*); Whitney, June 19, 1949 (*Baker*).

Tipula (*Oreomyza*) *pseudotruncorum* Alexander, 1920.—Coast: Saddle Mt., (Boyer), June 13, 1936 (*Macnab*). Cascades: Mount Hood-Hood River Meadows, 4,500 ft., July 17, 1947 (*M. M. Alexander*); Tilly Jane Creek, 5,600 ft., July 18, 1947, July 29-30, 1948 (*A & F*); Timberline Lodge, 5,500 ft., August 7, 1946, July 16, 1947 (*F*). Dutchman's Flat, Century Drive, 6,300 ft., August 5, 1948 (*A*). Crater Lake—near Annie Springs, 6,000 ft., August 2, 1946 (*M. M. Alexander*); along Lake trail, 6,300-6,500 ft., July 12, 1947 (*A*). Blue Mts.: Horseshoe Lake, 7,500 ft., July 26, 1929 (*Scullen*).

Tipula (*Oreomyza*) *shoshone* Alexander, 1946.—Coast: Cascade Head Experimental Forest, May 23, 1948 (*F*); Gunaldo Falls, May 13-June 30, 1949 (*F*). Willamette Valley: Peavine, Sta. 1, May 7-29, 1945, May 11, 1946, May 23, 1947; Sta. 2, May 17, 1949; Sta. 4, May 17, 1946 (*F*). Muddy Valley, McMinnville, May 3, 1945 (*F*). Cascades: Mount Hood-Eagle Creek, June 15, 1925 (*Melander*).

Tipula (*Oreomyza*) *tristis* Doane, 1901.—Willamette Valley: Peavine, Sta. 2, April 16, 1947 (*F*). Corvallis, April 26, 1908 (*Laura Hill*); Fern Ridge Dam, April 4, 1947 (*Malkin & Shotwell*); Forest Grove, May 5 (*Cole*); McMinnville, April 13, 1947 (*F*); Philomath, May 13, 1917 (*Entermile*).

Tipula (*Lunatipula*) *acuta* Doane, 1901.—Willamette Valley: Peavine, Sta. 1, May 1945, May 11, 1946 (*F*). Corvallis May 24, 1908 (*Laura Hill*), April 30, 1913 (*Roberts*), June 25, 1929 (*Scullen*); McMinnville, May 13, 1945 (*F*); Muddy Valley, McMinnville, June 7, 1945 (*F*). Southern Oregon: Cave Junction, 1,350 ft., May 17, 1947 (*Malkin*).

Tipula (*Lunatipula*) *aequalis* Doane, 1901.—Willamette Valley: Forest Grove, July 22 (*Cole*); Salem, May 1-5, 1947, reared, June 7, 1948 (*J. W. Bell*).

Tipula (*Lunatipula*) *albofascia* Doane, 1901 (*biarmata* Doane, 1912).—Willamette Valley: Peavine, Sta. 1, May 18, 1946, May 22, 1947, June 7, 1948 (*F*). Corvallis, May 22, 1898 (*Kincaid*), type. Southern Oregon: Cave Junction, 1,350 ft., August 27, 1948 (*Bowerman*); South slope of Siskiyou Summit, June 8, 1947 (*F*).

Tipula (*Lunatipula*) *armata* Doane, 1901 (*varia* Doane, 1901, ♀).—Coast: High Heaven, June 22, 1945, July 12, 1949 (*F*). Willamette Valley: Peavine, Sta. 1, May 11-24, 1946, Sta. 3, June 8-July 13, 1945, May 24, 1947, June 6, 1949; Sta. 3A, June 11-July 13, 1946 (*F*). Corvallis (*Cole* auct.); Forest Grove, May 17 (*Cole*). Southern Oregon: North slope of Siskiyou Summit, June 9, 1947 (*F*). Cascades: Mount Hood-Bear Springs, 3,200 ft., August 8-9, 1946 (*F*); Kelly Creek, June 22, 1947 (*F*); Metolius River, August 3, 1948 (*A & F*); Prospect, May 28-30, 1921 (*Dyar*).

Tipula (*Lunatipula*) *bisetosa* Doane, 1901.—Blue Mts.: Blue Mt., July 25, 1948 (*Davis*); Spring Creek, 3,900 ft., August 22, 1948, June 30, July 31, 1949 (*Baker*); Pine Creek, 4,000 ft., August 22, 1948 (*Baker*); Pendleton, along Umatilla River, July 5, 1948 (*A*). Wallawas: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948, in dense riverside thickets (*A*); Lazy T Ranch, July 15, 1949 (*Sperry*).

Tipula (*Lunatipula*) *calcarata* Doane, 1901.—Cascades: Mount Hood-Timberline Lodge, 5,500 ft., among mountain hemlock, August 7, 1946 (*A & F*). Crater Lake, without exact station, July 29, 1921 (*Dyar*); Mount McLoughlin, June 25, 1939 (*Aiken & Bohart*).

Tipula (*Lunatipula*) *californica* (Doane, 1908).—Willamette Valley: Peavine, without exact station, May 2, 1946 (*F*). Clackamas Co., May 15, 1946 (*J. F. Bock*); Corvallis, 1897; June 2, September 25 (*Cole* auct.); Forest Grove, May 20 (*Cole*); Medford,

May 20, 1921 (Dyar).—Southern Oregon: North slope of Siskiyou Summit, June 9, 1947 (F).

Tipula (Lunatipula) diabolica sp. nov.—Size above medium (wing, ♂, 16-18 mm.); mesonotal praescutum yellowish gray, with four very poorly differentiated brownish yellow stripes that are narrowly bordered by reddish yellow; antennae with basal three segments yellow, remainder of flagellum chiefly black; femora yellow, the tips narrowly brownish black; wings with a weak brown tinge, restrictedly patterned with darker brown; obliterative band at cord conspicuous; abdomen yellow, the median tergal stripe narrow, sublateral stripes obsolete or very narrow; male hypopygium with the tergite tumid or arched, the posterior portion with a feebly sclerotized dorsal margin and a more heavily blackened ventral ledge, the two margins separated by a thickened membranous area; lower tergal ledge with three emarginations separated by two acute teeth; inner dististyle complex, its outer basal lobe bearing several spinous points; eighth sternite sheathing, projecting caudad beyond the ninth sternite, the narrow apex fringed with very long yellow setae.

♂. Length, about 16-17 mm.; wing, 16-18 mm.; antenna, about 5-5.3 mm.

Frontal prolongation of head yellow, sparsely light gray pruinose above; nasus distinct; palpi with basal two or three segments yellowish brown to darker brown, the terminal segment black. Antennae with scape and pedicel light yellow, the first flagellar segment slightly darker yellow; succeeding flagellar segments brownish black, the enlargement black, outer segments more uniformly blackened; flagellar segments moderately incised, the longest verticils subequal to the segments. Head in front yellow, sparsely pruinose, behind dark brown, still darker on the sides of the posterior vertex.

Pronotum obscure yellow. Mesonotal praescutum with the ground light gray or yellowish gray, with four very poorly differentiated brownish yellow stripes that are narrowly and insensibly bordered by reddish yellow, the general effect being brownish yellow; posterior sclerites of notum slightly darker brown, including the midregion of the scutum and the scutellum. Pleura more uniformly yellow, very sparsely pruinose; dorsopleural region light yellow. Halteres brownish yellow, base of stem yellow, knob brownish black.

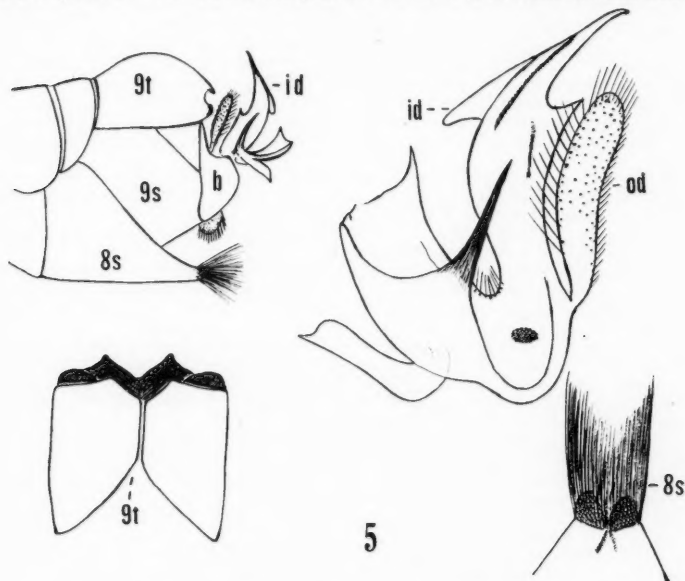


Fig. 5.—*Tipula (Lunatipula) diabolica* sp. nov., male hypopygium (See fig. 1 for explanation of symbols).

Legs with the coxae yellow, very sparsely pruinose; trochanters yellow; femora and tibiae yellow, the tips narrowly dark brown or bluish black, the amount subequal on all legs; basitarsi light brown, the tips and the remainder of tarsi passing into black; claws (male) toothed. Wings with a weak brownish tinge, the prearcular and costal fields deeper yellow or brownish yellow; stigma medium brown; very restricted darker brown spots at origin of R_s , tip of Sc , and over the anterior cord; obliterative band at cord relatively extensive and conspicuous, extending from before the stigma into the proximal end of cell M_2 ; no post-stigmal brightening; veins brown, more brownish yellow in the yellowed fields. Venation: $m-cu$ about one-third R_s ; R_{1+2} entire; m oblique, narrowing cell $1st\ M_2$ at its outer end.

Abdomen obscure yellow, the tergites with a narrow but conspicuous brown dorsal stripe that is very slightly interrupted at the posterior borders of the segments; sublateral dark stripes lacking or very narrow, becoming more clearly defined beyond the second tergite; lateral tergal borders gray; sternites more uniformly yellow; hypopygium relatively large, castaneous. Male hypopygium (Fig. 5) with the ninth tergite, $9t$, entirely separate from the sternite, conspicuously tumid or arched, the mid-dorsal area completely divided by a membranous line or groove; posterior portion with a distinct dorsal edge or margin that is feebly sclerotized and a more blackened, heavily sclerotized ventral ledge, the two edges separated by pale membrane; dorsal margin with a conspicuous U-shaped median notch; ventral ledge with three emarginations, the broad median notch U-shaped, the lateral pair shorter and shallower, separated by acute blackened teeth, the lateral denticles obtuse. Ninth sternite, $9s$, with the appendage small but conspicuously bilobulate, each lobule with long crinkly yellow setae; accessory sclerite of ninth sternite entire and unusually large. Basistyle entire, its posterior suture vertical and almost straight; upper angle of sclerite produced dorsad into a slender fingerlike point; posterior border not produced. Outer dististyle, od , large, extending caudad beyond the apex of the lower beak of the inner style, provided with long setae, certain of those on the outer margin unusually long. Inner dististyle, id , with the beak pale, long and slender; lower beak not blackened, subspinous, separated from the upper one by a U-shaped notch; dorsal crest unusually small and narrow, elevated at a strong angle, pale yellow; outer basal lobe large, complex and spinous, including a flattened scooplike blade that is produced at apex into weak tuberculate points, an inner long slender spine and an outer more flattened blade, the tip of the latter more or less truncate, the lower angle spinous, the upper angle obtusely rounded. Eighth sternite, $8s$, unusually sheathing, the apex jutting some distance beyond the ninth sternite; tip with a shallow V-shaped notch that is fringed with unusually long yellow setae, these more or less fimbriate, their tips unusually delicate and twisted; on either side of this narrow notch with a flattened lobe that bears additional similar setae.

Holotype, ♂, Mount Diablo, Contra Costa Co., California, 3,000 ft., April 28, 1939 (Aitken & Cazier). *Paratopotypes*, 2 ♂♂; *paratypes*, 3 ♂♂, Alum Rock Park, Santa Clara Co., California, May 5, 1939 (Aitken); 2 ♂♂, Livermore, Alameda Co., California, May 1, 1939 (Aitken & Cazier); Peavine Ridge, Oregon, Sta. 1, April 30-May 11, 1946; Sta. 3, May 24, 1947 (Fender).

This interesting fly differs from all other medium-sized yellow species by the structure of the male hypopygium, especially the very peculiar ninth tergite, the equally distinctive inner dististyle, and the eighth sternite. I am unable to indicate any species that I can consider as being closely allied.

Tipula (*Lunatipula*) *diacanthophora* Alexander, 1945.—Willamette Valley: Peavine, Sta. 3, July 21, 1946 (F). Hitherto from the Sierra Nevada, California.

Tipula (*Lunatipula*) *dido malheurensis* Alexander, 1950.—Blue Mts.: Beech Creek Forest Camp, Malheur National Forest, 4,500 ft., August 16, 1948 (A), types; Spring Creek, 3,900 ft., August 20, 1948 (Baker), types.

Tipula (*Lunatipula*) *dorsimacula dorsimacula* Walker, 1848 (*angustipennis* Loew, 1863).—Coast: Three Rivers, May 23, 1948 (F); Deer Creek, McMinnville, May 6, 1945 (F). Willamette Valley: Peavine, Sta. 1, May 6, 1946, April 21, 1947 (F). Corvallis (Cole auct.); Forest Grove, April 20-May 10 (Cole). Blue Mts.: Spring Creek, 3,900 ft., May 2-30, 1948, April 24-May 8, June 5, 1949 (Baker); Whitney, May 30, 1949 (Baker).

Tipula (*Lunatipula*) *dorsimacula shasta* Alexander, 1919.—Southern Oregon: Ashland-Lake of the Woods, June 10-11, 1945 (F). Cascades: Prospect, May 22-26, 1921 (Dyar).

Tipula (*Lunatipula*) *fenderi* sp. nov.—Size small (wing, male, under 14 mm.);

general coloration buffy gray, the praescutum with four brown stripes, the intermediate pair separated by a slightly wider ground line; wings with a brownish tinge; a conspicuous obliterative band before cord but no post-stigmal brightening; male hypopygium with the basistyle produced into a long glabrous arm, the tip obtusely rounded; inner dististyle with the dorsal crest low, conspicuously ribbed, the margin produced into acute blackened points; outer basal lobe very reduced.

♂. Length, about 12-13 mm.; wing, 12-13.3 mm.; antenna, about 5-5.4 mm.

Frontal prolongation of head obscure yellow, more or less pruinose above; nasus distinct; palpi brown, with pale incisures, the terminal segment blackened. Antennae (male) relatively long, as shown by the measurements; basal three segments yellow, the first flagellar segment a trifle more infuscated; succeeding segments very vaguely bicolored, the basal swellings black, the stem dark brown, the outer segments more uniformly darkened; flagellar segments elongate, moderately incised, the basal swellings small; verticils shorter than the segments. Head gray, more yellowed on anterior vertex.

Pronotum yellow. Mesonotum with the ground buffy gray, the praescutum with four brown stripes, the intermediate pair separated by a ground line of slightly greater width; centers of scutal lobes infuscated; scutellum and postnotum more pruinose. Pleura gray, the ventral portions more infuscated but pruinose; dorsopleural membrane pale. Halteres with stem yellow, knob infuscated. Legs with the coxae and trochanters yellow; femora yellow, the tips narrowly brownish black, the amount subequal on all legs; tibiae obscure yellow, the tips more broadly blackened; tarsi black; claws of male toothed. Wings with a brownish tinge, somewhat stronger on outer portion, the prearcular field and cells Sc and Cu_1 more yellowed; stigma oval, pale brown; a small pale brown cloud at origin of Rs ; a conspicuous obliterative band at cord, extending from before the stigma across the proximal half of cell $1st\ M_2$ into the base of cell M_{3+4} , with a further inconspicuous seam along vein M_4 to the posterior margin; no post-stigmal brightening; veins brown, more yellowed in the brightened portions. Squamal setae about six in number. Venation: R_{1+2+3} long, entire; Rs about three times $m-cu$; petiole of cell M_1 longer than m .

Abdomen obscure yellow, the apex of tergites two and three weakly darkened; small lateral darkenings at near midlength of tergite two and subbasal on tergites three and four; hypopygium concolorous with the remainder of abdomen. Male hypopygium (Fig. 6) with the ninth tergite, $9t$, simple, the caudal margin with a broad V-shaped notch, the lateral lobes relatively narrow; setulae of margin exceedingly small and delicate. Ninth

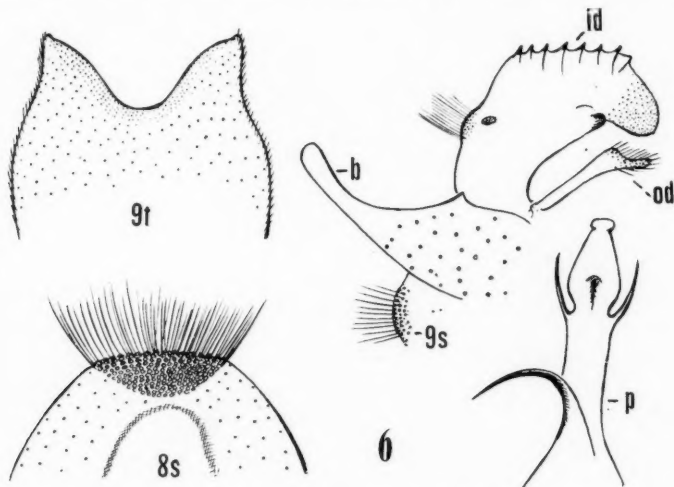


Fig. 6.—*Tipula (Lunatipula) fenderi* sp. nov., male hypopygium (See fig. 1 for explanation of symbols).

sternite, *9s*, with the appendage very small, darkened, provided with elongate setae. Basistyle, *b*, with the suture indicated on its ventral portion; outer end of style produced caudad into a long glabrous arm, the tip obtusely rounded; basal part of arm with conspicuous setae. Outer dististyle, *od*, with the outer half irregularly produced, darkened. Inner dististyle, *id*, with the beak deep, its apex obtusely rounded; lower beak very small, blackened; outer basal lobe exceedingly reduced, represented by a low tubercle that bears a brush of elongate setae; dorsal crest low but conspicuous by about eight flutings that are produced at margin into small blackened spines or points that give a serrate appearance to the style. Phallosome, *p*, consisting of a central depressed-flattened organ, beyond midlength with a subtending spine on either side; at base of organ with a strong sickle-shaped rod or spine. Eighth sternite, *8s*, broad, moderately sheathing, its caudal margin virtually transverse, with a broad low cushion that is densely provided with long yellow setae.

Holotype, ♂, Peavine Ridge, Coast Range, Sta. 3A, June 19, 1946 (K. M. Fender). *Paratopotype*, ♂, with the type.

I take unusual pleasure in naming this distinct fly for Mr. Kenneth Mark Fender, to whom much of the success of the present list is due. There are rather numerous regional species of the subgenus that have the basistyle of the male hypopygium more or less produced into a lobe or spine. Among such species, the present fly is perhaps most similar to *Tipula* (*Lunatipula*) *saxemontana* Alexander, especially in the nature of the basistyle. In some other details of structure of the hypopygium it more suggests species such as *T. (L.) atrisumma* Doane, but is amply distinct from all previously defined species.

Tipula (*Lunatipula*) *impudica* Doane, 1901.—Eastern Oregon: Juntura, May 26, 1948 (Davis).

Tipula (*Lunatipula*) *lamellata* Doane, 1901 (*rangiferina* Alexander, 1915).—Cascades: Mount Hood-Hood River side, 3,000 ft., July 29, 1921 (Melander). Metolius River, August 3, 1948 (A & F); Tumalo Creek, 3,610 ft., August 14, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, August 20, 1948 (A & Baker), July 31-August 5, 1949 (Baker). Wallawas: Lostine, 3,375 ft., July 2, 1948 (A); Lazy T Ranch, 4,500 ft., July 4-8, August 25, September 9, 1949 (Sperry).

Tipula (*Lunatipula*) *leechi* Alexander, 1938.—Coast: Saddle Mt. (Boyer), June 24,

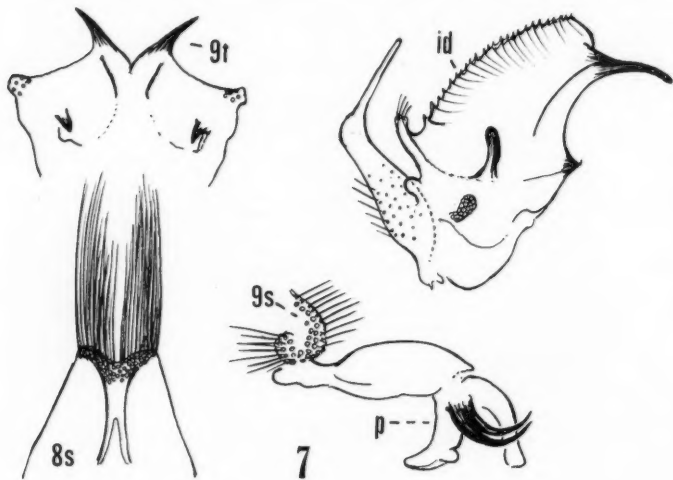


Fig. 7.—*Tipula* (*Lunatipula*) *macnabi* Alexander, male hypopygium (See fig. 1 for explanation of symbols).

1938 (*Macnab*). Cascades: Mount Hood-Horsethief Meadows, 3,400 ft., August 8, 1946 (A); Robin Hood Forest Camp, 3,560 ft., August 8, 1946 (F).

Tipula (Lunatipula) lucida Doane, 1901.—Willamette Valley: McMinnville, May 7, 1944 (D. & K. Fender). Cascades: Mount Hood-Hood Rapids, July 29, 1921 (*Melander*). Indian Ford, 3,240 ft., August 5, 1948 (A); Metolius River, August 3, 1948 (A & F). Ochocos: Wildwood Forest Camp, 4,500 ft., August 15, 1948 (A); flying in some numbers about the trunks of trees, especially Ponderosa Pine, Douglas Fir, and Western Larch. Blue Mts.: Spring Creek, 3,900 ft., July 25-August 22, 1948 (Baker); Beech Creek Forest Camp, Malheur National Forest, August 16, 1948 (A).

Tipula (Lunatipula) macnabi Alexander, 1939.—Coast: Saddle Mt. (Boyer), June 21, 1932, July 28-August 1, 1935, July 30, 1936, April 15, September 25, 1937 (*Macnab and associates*); types. Willamette Valley: Peavine, Sta. 3, July 21, 1946, May 20-30, 1947 (F). Male hypopygium (Fig. 7) with the posterior margin of tergite, 9t, produced into two divergent black horns or spines; lower face of tergal plate with a small blackened tooth and a low blackened flange near the marginal spines. Limits of outer dististyle difficult to determine in available slides but apparently expanded into a head at outer end. Inner dististyle, id, with the beak long and slender; lower beak appearing as a small triangular point that is far removed from the beak. From the extreme base of the inner style or apex of the basistyle arises an elongate arm that terminates in a narrow rod or spine, in cases, this structure even broader on its basal portion than shown. Eighth sternite, 8s, strongly narrowed and sheathing, the gently emarginate apex with two brushes of long yellow setae.

I believe that the nearest relatives of this isolated fly are *Tipula (Lunatipula) modoc* Alexander and *T. (L.) perfidiosa* Alexander.

Tipula (Lunatipula) macrolabis Loew, 1864 (*spectabilis* Doane, 1901).—Blue Mts.: Spring Creek, 3,900 ft., June 25, 1948 (A), June 30, 1949 (Baker). Wallows: Above the Lazy T Ranch, 5,000 ft., July 6-9, 1949 (*Sperry*).

Tipula (Lunatipula) megalabiata Alexander, 1915.—Cascades: Mount Hood-Bear Creek, 1,400 ft., July 16, 1947 (A); Hood River side, 3,000 ft., July 29, 1921 (*Melander*); Cloudcap Inn Junction, August 9, 1946 (A & F); Polally Forest Camp, 3,000 ft., August 9, 1946 (A); Robin Hood Forest Camp, 3,560 ft., August 8, 1946 (A & F); Still Creek, 3,600 ft., July 31, 1948 (A & F). Metolius River, August 3-4, 1948 (A & F); Odell Lake, 4,760 ft., August 6, 1948 (A).

Tipula (Lunatipula) olympia Doane, 1912 (*concinna* Doane, 1901; *flavomarginata* Doane, 1912).—Willamette Valley: Peavine, Sta. 3, May 20, 1947 (F); Rock Creek, Corvallis, April 24, 1940.

Tipula (Lunatipula) pellucida Doane, 1912 (*clara* Doane, 1901; *pyramis* Doane, 1912).—Blue Mts.: Spring Creek, 3,900 ft., May 30, 1948, May 15, 1949 (Baker). Steens Mts.: Fish Lake, 7,000 ft., July 11, 1927 (*Scullen*).

Tipula (Lunatipula) praecisa Loew, 1872.—Willamette Valley: Peavine, Sta. 3, May 25, 1945, July 21, 1946, May 15, 1947 (F). McMinnville, June 25-July 2, 1946, June 14-30, 1948 (F); Panther Creek, McMinnville, July 14, 1948 (F). Cascades: Kelly Creek, June 22, 1947 (F).

Tipula (Lunatipula) pubera Loew, 1864.—Coast: High Heaven, May 4, 1947 (F). Willamette Valley: Peavine, Sta. 1, May 18-June 20, 1946, May 22-23, 1947 (F); Sta. 3, May 29, 1946; Sta. 3A, May 29, 1947, June 8-9, July 14, 1948 (F). Corvallis, May 5, 1925; May 12 (*Gentner*); Silver Creek Falls, July 8, 1949 (F & Davis). Southern Oregon: Cave Junction, 1,325 ft., August 27, 1948 (*Bowerman*).

Tipula (Lunatipula) retusa Doane, 1901.—Willamette Valley: Peavine, Sta. 1, April 30-May 11, 1946, May 22, 1947; Sta. 2, May 21, 1947; Sta. 3, May 20-24, 1947; Sta. 3A, June 2, 1948 (F). Forest Grove, July 22 (*Cole*); McMinnville, May 30, 1948 (F). Southern Oregon: Siskiyou Summit, June 10, 1945 (F). Cascades: Mount Hood-Oneonta Gorge, 100 ft., July 19, 1947 (F).

Tipula (Lunatipula) siskiyouensis Alexander, 1949.—Southern Oregon: O'Brien, Siskiyou National Forest, 1,475 ft., March 24, 1940 (*Post, Maris and Ross*); type. Male hypopygium (Fig. 8) with the ninth tergite, 9t, large, transverse; caudal border with four lobes, the sublateral or outer pair each appearing as a long slender rod, the tip obtuse, blackened; intermediate lobes much shorter, blackened, their tips obtuse; margin between the lobes produced into a low pale triangular blade on either side of the midline. Outer dististyle, od, an unusually small pale blade, flattened, the upper edge with three black setae, the remainder of surface glabrous. Inner dististyle, id, of peculiar conformation; what seems to represent the normal beak is slender, straight, subtended above by a pale membranous dorsal crest; posterior portion of main body of style produced into a

flattened blade that is unequally bispinous, the upper arm a strong erect spine, the lower one a small triangular point; outer basal lobe very conspicuous, appearing as a flattened blade that is longer than the remainder of style, dilated on basal half and here provided with numerous long pale setae, thence narrowed into a more slender apical portion, the whole bent forwards over the main body of style. Gonapophyses, *g*, paired, each half terminating in a long decurved point. Eighth sternite, *8s*, bearing a flattened lobe or blade on either side of midline, each with a brush or tuft of very long yellow setae that are very conspicuously roughened by lateral hairlike projections to produce an unusually fuzzy appearance.

Tipula (Lunatipula) snoqualmiensis Alexander, 1945.—Cascades: Odell Lake, Princess Creek Forest Camp, 4,760 ft., August 6, 1948 (*F*); resting on tree trunk. Hitherto only from Washington (Alexander, 1949: 285-286, fig. 9).

Tipula (Lunatipula) splendens Doane, 1901.—Cascades: Dutchman's Flats, 6,100 ft., August 5, 1948 (*F*); Metcalf River, 2,600 ft., June 15, 1947 (*F*). Blue Mts.: Spring Creek, 3,900 ft., July 31, 1949 (*Baker*); Beech Creek Forest Camp, Malheur National Forest, 4,500 ft., August 16, 1948 (*A*). Wallows: Lazy T Ranch, 4,500 ft., September 1, 1949 (*Grace Sperry*); Lostine Valley, 5,500 ft., August 18, 1948 (*A*); numerous flying among the evergreens.

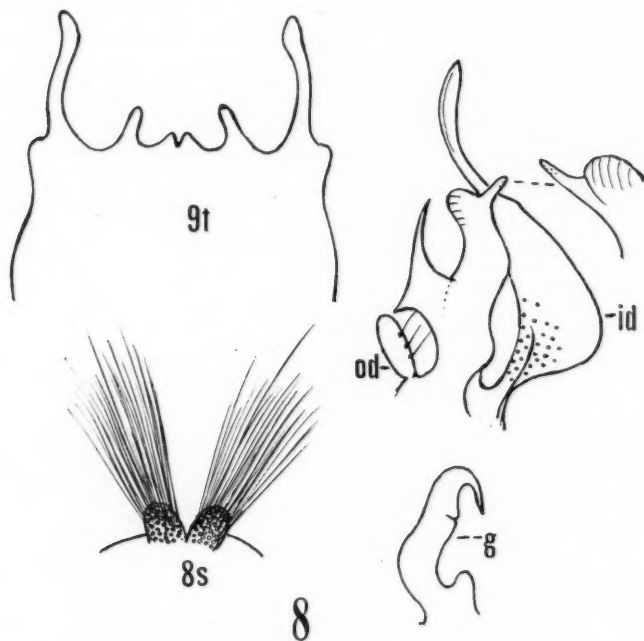


Fig. 8.—*Tipula (Lunatipula) siskiyouensis* sp. nov., male hypopygium (See fig. 1 for explanation of symbols).

Tipula (Lunatipula) uncinata uncinata Doane, 1901.—Willamette Valley: Corvallis, May 25 (*Cole auct.*). Cascades: Mount Hood-Hood River side, 3,000 ft., July 29, 1921 (*Melander*); Clear Lake, 3,300 ft., August 8, 1946 (*A*); Eagle Creek Forest Camp, July 18, 1947 (*F*); Polally Forest Camp, August 9, 1946 (*F*). Elk Lake, Century Drive, 4,900 ft., August 6, 1948 (*F*).

Tipula (Lunatipula) uncinata bifila subsp. nov.—Very close to the typical form, differing in certain details of the male hypopygium. The latter (Fig. 9) has the appendage of the ninth sternite, 9t, elongate, terminating in a powerful reddish spine, the lower surface back from the spine with about six powerful setae scattered along the length. Phallosome, p, symmetrical, as in *uncinata*; tips of the inner apophyses produced into very long slender spines. Ninth tergite with the outer lateral points slender, directed laterad.

Holotype, ♂, Gold Beach, Curry Co., July 11, 1925.

Tipula (Lunatipula) usitata usitata Doane, 1901.—Willamette Valley: Peavine, Sta. 1, May 18, 1946, May 22, 1947; Sta. 2, May 31, 1946; Sta. 3, May 20-24, 1947, June 8, 1948; Sta. 3A, May 12, 1947 (F). Corvallis, June 2 (Kincaid), type; Eugene, May 1947 (Malkin); McMinnville, June 1, 1948 (F).

Tipula (Lunatipula) usitata aurantionota Alexander, 1945.—Coast: Saddle Mt. (Boyer), June 2, 1934; July 21, August 1, 1935 (Macnab), types; High Heaven, June 22, 1945 (F). Willamette Valley: Peavine, Sta. 2, May 18-31, 1946 (F). McMinnville, July 16, 1933 (Macnab).

Tipula (Lunatipula) vittatipennis Doane, 1912 (*albovittata* Doane, 1901).—Willamette Valley: McMinnville, May 24, 1947 (D. McKey-Fender); Muddy Valley, McMinnville, June 6, 1945 (F). Southern Oregon: Cave Junction, 1,325 ft., August 27, 1948 (Bowerman); North slope of Siskiyou Summit, June 9, 1947 (F). Cascades: Mount Hood-Eagle Creek, August 2, 1921 (Melander).

Tipula (Hesperotipula) fragmentata Dietz, 1919.—Coast: Chetco River, August 11, 1948 (F); Glenada, June 9, 1946 (Malkin). Willamette Valley: Forest Grove, May 20, 1918 (Cole).

Tipula (Hesperotipula) streptocera Doane, 1901.—Coast: High Heaven, June 22, 1945, July 12, 1949 (F); Saddle Mt. State Park, July 24, 1949 (F); Tierra del Mar, June 30, 1949 (F). Willamette Valley: Peavine, Sta. 1, May 2-11, July 12, August 6, 1946, May 27-June 24, 1947; Sta. 2, June 27, 1946; Sta. 3, July 16-21, 1946; Sta. 3A, June 30, 1947 (F). McMinnville, in skunk cabbage association, May 16, 1945 (F); Muddy Valley, McMinnville, May 22, 1945 (F); Silver Creek Falls, 1,000 ft., August 1, 1948 (A & F), July 8, 1949 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., July 16, 1947 (F); Horsetail Falls, July 19, 1947 (A & F); Eagle Creek Forest Camp, July 18, 1947 (A & F). Blue Mts.: Spring Creek, 3,900 ft., June 24-28, July 25, August 18, 1948, June 5-30, 1949 (Baker).

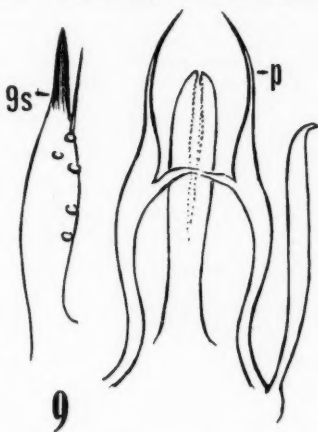


Fig. 9.—*Tipula (Lunatipula) uncinata bifila* subsp. nov., male hypopygium (See fig. 1 for explanation of symbols).

CYLINDROTOMINAE

Cylindrotoma occidentalis (Alexander, 1927).—Cascades: Mount Hood-Hood River Meadows, 4,475 ft., August 8, 1946, July 17, 1947, July 31, 1948 (A & F). This distinct fly was originally described in the genus *Phalacrocer* but seems to be more correctly placed in the present group. The species shows a surprising degree of variation in venation, particularly of the medial field. This was shown in the type (Longmire Springs, Mount Rainier, Washington) and likewise in virtually all specimens of the present series (see Alexander, *Genera Insectorum*, Fasc. 187, *Cylindrotominae*, pl. 2, fig. 4; 1927). Since the distinctions employed in separating *Cylindrotoma* and *Phalacrocer* are chiefly venational and apply particularly to the medial field, the indication earlier

made that *Phalacrocer* should perhaps be considered as being not more than a subgenus of *Cylindrotoma* seems justified.

Cylindrotoma splendens splendens Doane, 1900 (*juncta* Coquillett, 1900).—Coast: Saddle Mt. (Boyer), May 6, 1934, June 11, 1935, June 13, 1936, June 18, 1937 (*Macnab* and *associates*); Castle Rock, May 13, 1949 (F); High Heaven, May 4, 1947 (F); Sourgrass Creek, May 17, 1948 (F). The 1937 Boyer specimen has the venation abnormal, one wing having an adventitious crossvein in cell R_5 , as in the extinct group *Cytaromyia* Scudder. All of the above specimens represent the typical form, having heavily blackened praescutal stripes in both sexes.

Cylindrotoma splendens pallescens Alexander, 1930.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F); North Fork of Iron Creek, July 30, 1948 (F); Still Creek, July 16, 1947 (A & F). Big Meadows, North Santiam, August 3, 1948 (A & F); Odell Lake, 4,760 ft., July 14, 1947 (A). Crater Lake-Along small stream on Lake Road above Annie Springs, 6,200 ft., August 2, 1946, July 12, 1947 (A). Blue Mts.: Spring Creek, 3,900 ft., June 5, 1949 (*Baker*); Little Antone Creek, 4,100 ft., June 27, 1948 (A); Little Phillips Creek, 3,800 ft., July 3, 1948 (A). Wallows: Wallowa Creek, at Power Plant spring, 4,635 ft., June 29-30, 1948 (A); above Lazy T Ranch, 5,500 ft., July 17, 1949 (*Sperry*); Lostine Valley Guard Station, 4,900 ft., June 30, 1948 (A). All of the above have the dark markings of the praescutum virtually lacking, particularly in the male sex.

LIMONIIINAE

LIMONIIINI

Limonia (Limonia) bistigma (Coquillett, 1905, as *bestigma*) (*tributaria* Alexander, 1943).—Coast: Big Creek, Sitkum, August 12, 1948 (*H. W. Thorne*); Chetco River, August 11, 1948 (F); Glenada, June 9 1946 (*Malkin*); Gualdo Falls, June 30, 1949 (F); High Heaven, June 22, 1945, August 6, 1946 (F); Humbug Mountain State Park, August 11, 1948 (F); Saddle Mountain State Park, July 24, 1949 (F); Tierra del Mar, June 30, 1949 (F); Wheeler, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 3A, July 5-9, 1946, June 17, July 7, 1947, June 24, July 13, 1948 (F). Silver Creek Falls, August 2, 1948 (F), July 8, 1949 (F). Cascades: Mount Hood-Bear Creek, July 16, 1947, August 1, 1948 (A & F); Bear Springs, August 8, 1946 (A & F); Beaver Creek, August 7, 1946, July 16, 1947 (F); Cloudcap Inn Junction, August 9, 1946 (F); Hood River side at 3,000 ft., July 29, 1921 (*Melander*); Hood River Meadows, July 17, 1947 (A & F); Horsethief Meadows, August 9, 1946, July 19, 1947 (A & F); Polally Forest Camp, August 9, 1946 (A); Multnomah Falls, July 19, 1947 (A & F); Salmon River, July 30, 1948 (F); Still Creek, July 16, 1947, July 31, 1948 (A & F); Wahkeena Falls, September 9, 1934 (*Melander*). Hazel Creek, near Dexter, July 15, 1947 (A); Merrill Creek, N. Santiam, August 17, 1947 (*Albright*); Odell Lake, August 6, 1948 (A); Metolius River, June 15, 1947 (F); Salt Creek Falls, August 7, 1948 (F); Willis Creek, N. Santiam, August 17, 1947 (F). The species is closely allied to the Palaearctic *tripunctata* (Fabricius, 1781).

Limonia (Limonia) sciophila (Osten Sacken, 1877).—Coast: Cascade Head Experimental Forest, July 6, 1945 (*Shelford*); Castle Rock, March 31, 1949 (F); Chetco River, March 18, 1940 (*Post & Ross*), August 11, 1948 (F); Deer Creek, McMinnville, May 6, 1945 (F); Gales Creek, September 5, 1948 (F); Glenada, June 9, 1946, May 23, 1947 (*Malkin*); Gualdo Falls, May 13, 1949 (F); Hemlock, April 5, 1949 (F); High Heaven, June 22, 1945, July 6, August 16, 1946, May 4, 1947 (F); Humbug Mountain State Park, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Lake Tahkenitch, August 12, 1948 (F); Lee's Camp, September 18-25, 1949 (*Davis*); Pacific City, May 23, 1948 (F); Saddle Mt. (Boyer), September 8, 1933, April 27, September 22, October 26, 1935, May 15, 1937 (*Macnab & Dirks*); Salmon River, near Boyer, August 12, 1948 (F); Sourgrass Creek, May 17, 1948 (F); Three Rivers, May 23, 1948 (F); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, no station, May 5-14, July 13, September 10, October 10, 1945; Sta. 1, April 30, May 6, 1946, May 1, 1947; Sta. 3, September 13, 1946, May 14, July 8, September 3, 1947; Sta. 3A, May 3, September 17, October 12, 1946, May 5, 1947, August 30, September 13, 1948; Sta. 4, May 2, 1947 (F). Albrights, Dayton, September 19, 1946 (F); Corvallis, April 20, May 28 (*Cole* auct.); Forest Grove, September-October (*Cole*); Mount Angel (*Epper*); Silver Creek Falls, May 9, August 2, 1948, July 8, 1949 (F). Southern Oregon: State Line Creek, August 9, 1948 (A & F); Roseburg, April 6, 1930 (*J. Wilcox*). Cascades: Mount Hood-Bear Creek, July 16,

1947, August 1, 1948 (F); Beaver Creek, July 16, 1947 (A & F); Eagle Creek Forest Reservation, July 1, 1917 (Melander); Hood River side, 3,000 ft., July 29, 1921 (Melander); Hood River Meadows, July 17, 1947 (F); Horsethief Meadows, August 9, 1946, July 18, 1947 (A & F); Oneonta Gorge, July 19, 1947 (A & F); Robin Hood Forest Camp, August 8, 1946 (F); Salmon River, July 30, 1948 (F); Still Creek, July 16, 1947, July 31, 1948 (A & F). Big Meadows, N. Santiam, August 17, 1947, August 3, 1948 (F); Deschutes River Guard Station, August 6, 1948 (F); Elk Lake, Century Drive, August 6, 1948 (F); Hazel Creek, near Dexter, July 15, 1947 (A); Odell Lake, August 4, 1946, July 14, 1947, August 6, 1948 (A); Trout Creek, August 24, 1944 (Knowlton); Tumalo Creek, August 15, 1948 (A); Willis Creek, N. Santiam, August 17, 1947 (Albright). Crater Lake-Annie Spring, August 1-3, 1946 (A). Ochoco Mts.: Mossy Rock Forest Camp, August 15, 1948 (A). Blue Mts.: Spring Creek, June 24-26, July 25, August 29, September 12, 1948, June 5-30, 1949 (Baker); Langdon Lake, August 16-17, 1948 (A), very abundant and extremely variable in size; North Powder River at 3,800 ft., June 27, 1948 (A); Pine Creek, June 30, 1949 (Baker & Sperry); South Fork of Upper Walla Walla River, 1,450 ft., July 4, 1948 (A). Wallows: Aneroid Lake trail, 7,000 ft., July 26, 1949 (Baker); Eagle Cap Wilderness Area, 5,000 ft., June 28, 1948 (A); French Forest Camp, August 18, 1948 (A); Hurricane Creek, 5,460 ft., July 11, 1949 (Sperry); Lazy T Ranch, July 17, September 3, 1949 (Sperry); Lostine Valley Guard Station, June 30, 1948 (A). The species is very close to the Palaearctic *nubeculosa* (Meigen, 1804).

Limonia (Limonia) tristigma (Osten Sacken, 1859).—Wallows: Lazy T Ranch, 4,500 ft., July 4, 1949 (Sperry), a single ♀. Hitherto not known from farther west than Colorado. Probably only racially distinct from the Palaearctic *trivittata* (Schummel, 1829).

Limonia (Metalimnobia) annulus triphaea subsp. nov.—Closest to *L. (M.) annulus cinctipes* (Say), differing in slight details of coloration and structure of the male hypopygium.

♂. Length, about 12 mm.; wing, 13 mm.

General coloration very dark, including the head and much of the thorax, the obscure yellow of the praescutum and scutum much restricted. Head dark. Femora with three distinct darkened rings, as in *annulus immatura* (Osten Sacken, 1859), the latter differing otherwise in the structure of the male hypopygium, particularly of the dististyles. Male hypopygium with the dorsal dististyle relatively narrow, the tip a slightly decurved blackened spine.

Holotype, ♂, McMinnville, on Fender property, May 29, 1948 (Fender). *Paratopotype*, ♂.

Limonia (Metalimnobia) annulus cinctipes (Say, 1823).—Wallows: Trail above Lazy T Ranch, 5,200 ft., July 6, 1949 (Sperry).

Limonia (Metalimnobia) californica (Osten Sacken, 1861).—Coast: Gualdo Falls, May 13, 1949 (F); Saddle Mt. (Boyer), July 13, 1933 (*Macnab and associates*). Willamette Valley: Forest Grove, April 20 (Cole). Cascades: Mount Hood-Hood River side, 4,000 ft., June 25, 1935 (Melander); Robin Hood Forest Camp, 3,560 ft., July 18, 1947 (F). Odell Lake, 4,790 ft., August 6, 1948 (F).

Limonia infusca (Doane, 1900) (*adjecta* Doane, 1908; *nitidiuscula* Alexander, 1927).—Coast: Agate Beach, March 27, 1949 (F); Cascade Head Experimental Forest, May 23, 1948 (F); Deer Creek, McMinnville, May 6, 1945 (F); Gales Creek, September 5, 1948 (F); Gualdo Falls, May 17, 1948, May 13, June 6, 1949 (F); Hemlock, April 5, 1949 (F); High Heaven, June 22, 1945, May 4, 1947, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Lake Tahkenitch, August 12, 1948 (F); Meadow Lake Road, Carlton, October 13, 1945 (F); Saddle Mt. (Boyer), March 31, October 3, 1934, April 27, May 12, July 28, August 15, 1935, April 25, 1936, May 22, August 16, 1937 (*Macnab and associates*); Salmon River, near Boyer, August 12, 1948 (F); Sand Lake, April 12, 1949 (F); Three Rivers, May 23, 1948 (F); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, no station, April 28-May 31, 1945, on sword fern; Sta. 3A, June 24, August 30, 1948 (F). Albrights, Dayton, September 19, 1946 (F); Happy Valley, McMinnville, April 14, 1946 (F); Silver Creek Falls, May 9, August 2, 1948 (F). Southern Oregon: State Line Creek, August 9, 1948 (A & F); Store Gulch Forest Camp, August 8, 1948 (A). Cascades: Mount Hood-Beaver Creek, July 16, 1947 (F); Horsethief Meadows, August 9, 1946 (A & F); Still Creek, July 16, 1947 (A & F). Odell Lake, 4,800 ft., August 4, 1946, July 13, 1947 (A); Schweitzer Creek, 1,000 ft., August 5, 1946 (A); Willis

Creek, August 17, 1947 (*Albright*). Wallows: Lostine Valley Guard Station, June 30, 1948 (*A*); Wallowa Creek, 4,675 ft., June 29, 1948 (*A*).

Limonia simulans concinna (Williston, 1893).—Coast: Marys Peak, June 1, 1946 (*F*). Willamette Valley: Orchard View, McMinnville, May 4, 1949 (*F*). Cascades: Mount Hood-Hood River, June 3, (*Cole*); Hood River side at 4,000 ft., June 25, 1935 (*Melander*); Multnomah Falls, 100 ft., August 9, 1946, July 17, 1947 (*A & F*). Odell Lake, 4,760 ft., August 6, 1948 (*F*); Salt Creek Falls, July 14, 1947 (*M. M. Alexander*). Eastern Oregon: Juntura-Vale, May 13, 1947 (*Albright*).

Limonia venusta (Bergroth, 1888) (*duplicata* Doane, 1900; *negligens* Alexander, 1927).—Coast: High Heaven, Edmunds Ranch, April 1, 1949 (*F*); Jordan Creek, September 5, 1948 (*F*). Willamette Valley: Peavine, Sta. 2, June 27, 1946 (*F*). Cascades: Mount Hood-Stream below timberline, 5,000 ft., July 16, 1947 (*A*); Hood River Meadows, August 8, 1946, July 17, 1947, July 31, 1948 (*A & F*); Still Creek, July 17, 1947 (*A & F*). Blue Mts.: Anthony Lake, 7,100 ft., June 27, 1948 (*A & Baker*), flying in small swarms beneath the evergreens; Langdon Lake, 4,970 ft., July 3, 1948 (*A*); Spring Creek, 3,900 ft., May 2, 1948 (*Baker*); Whitman National Forest, June 14, 1947 (*F*). Wallows: Lazy T Ranch, 4,500 ft., August 29-31, 1949 (*Sperry*); Lostine Valley, 5,500 ft., August 18, 1948 (*A*).

Limonia (Geranomyia) communis (Osten Sacken, 1859) (*canadensis* of authors, nec Westwood, 1835).—Southern Oregon: Store Gulch Forest Camp, swept from willows at edge of Illinois River, 950 ft., August 9, 1948 (*A*).

Limonia (Geranomyia) diversa (Osten Sacken, 1859).—Coast: High Heaven, June 22, 1945 (*F*); Jordan Creek, September 5, 1948 (*F*). Willamette Valley: Peavine, Sta. 1, April 23, June 20, 1946 (*F*); Sta. 3, July 2-16, 1946 (*F*). Orchard View, McMinnville, May 4, 1949 (*F*). Southern Oregon: O'Brien, August 9, 1948 (*F*); Store Gulch Forest Camp, along Illinois River, August 9, 1948 (*A & F*). Cascades: Mount Hood-Hood River, October 30 (*Cole* auct.); Still Creek, July 16, 1947 (*A & F*). Cascadia, August 2, 1948 (*A & F*); Dell Creek, Willamette River, July 14, 1947 (*A*); Salt Creek Falls, 3,800 ft., July 14, 1947, August 8, 1948 (*A & F*).

Limonia (Dicranomyia) acerba Alexander, 1943.—Willamette Valley: Willamette River near Dayton, on gravel bars, April 24, 1949 (*F*). Southern Oregon: Ashland-Lake of the Woods, June 11, 1945 (*F*). Cascades: Mount Hood-Still Creek, 3,600 ft., July 16, 1947 (*F*).

Limonia (Dicranomyia) athabascæ (Alexander, 1927).—Coast: Coquille River, Sitkum, August 5, 1948 (*H. W. Thorne*); Gualdo Falls, May 13, 1949 (*F*); Humburg Mountain State Park, August 11, 1948 (*F*). Willamette Valley: Peavine, June 18, 1948; Sta. 1, April 30, June 20, July 26, 1946, May 15, July 3, 1947, May 27, 1949; Sta. 2, September, October 1945, May 10, July 12, 1946, May 22, 1948; Sta. 3, April 26, June 26, July 2-16, 1946, May 7, 1947, April 20, May 25, 1948 (*F*). McMinnville, May 7, 1944 (*F*); Muddy Valley, McMinnville, May 24, 1945 (*F*). Cascades: Mount Hood-Bear Springs, August 8, 1946 (*F*); Clear Lake, 3,300 ft., October 7, 1945 (*F*). Cultus Lake, 4,670 ft., August 6, 1948 (*A*); Dell Creek, July 14, 1947 (*A*); Metolius River, 2,200 ft., June 14, 1945, August 3, 1948 (*A & F*); Rivers Edge Forest Camp, Willamette River, 1,000 ft., August 5, 1946 (*A*). Blue Mts.: Pine Creek, June 30, 1949 (*Baker & Sperry*); Langdon Lake, 4,970 ft., July 4, August 16, 1948 (*A*); Spring Creek, 3,900 ft., June 24-26, 1948 (*A & Baker*); Vale, May 19, 1949 (*Davis*); Whitney, June 19, 1949 (*Baker*). Wallows: Lostine Valley, 4,900 ft., June 30, 1948; 5,500 ft., August 19, 1948 (*A*); Wallowa Lake, June 30, 1948 (*A*).

Limonia (Dicranomyia) brevivena (Osten Sacken, 1869).—Willamette Valley: Peavine, no station number, May 31, 1945 (*F*). Cascades: Metolius River, August 3, 1948 (*A & F*). Eastern Oregon: Mountain Creek, near junction with the John Day River, August 16, 1948 (*A*); Seneca, Malheur National Forest, June 12, 1947 (*F*); Warner Lakes, June 12, 1947 (*F*). Blue Mts.: Anthony Lake, 7,000 ft., June 27, 1948 (*A*); Whitman National Forest, June 14, 1947 (*F*); Whitney, June 19, 1949 (*Baker*). Wallows: Johnson Park, Wallowa River, 2,750 ft., August 20, 1948 (*A*).

Limonia (Dicranomyia) citrina (Doane, 1900).—Blue Mts.: Langdon Lake, 4,970 ft., July 2-4, 1948 (*A*), July 17, 1948 (*Lane*); in marshes at lake margin, abundant among *Camassia* and *Veratrum*; Whitney, May 30, June 19, 1949 (*Baker*).

Limonia (Dicranomyia) fulva fulva (Doane, 1900).—Coast: Sourgrass Creek, May 17, 1948 (*F*). Willamette Valley: Peavine, May 4, 1945, on sword fern (*F*). Cascades: Mount Hood-Hood River Meadows, 4,500 ft., August 8, 1946 (*A*); Still Creek, July 16, 1947 (*A & F*).

Limonia (Dicranomyia) fulva fulvoides Alexander, 1943.—Blue Mts.: Starr Creek, Malheur National Forest, May 30, 1949 (Baker).

Limonia (Dicranomyia) gracilis (Doane, 1900) (*halterella* Edwards, 1921).—Cascades: Mount Hood-Multnomah Falls, August 9, 1946 (F). Big Meadows, North Santiam, August 17, 1947 (F); Salt Creek Falls, 3,800 ft., August 7, 1948 (A); Tombstone Meadows, South Santiam, August 17, 1947 (Albright). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker); August 20, September 6, October 3, 1948 (Baker).

Limonia (Dicranomyia) halterata (Osten Sacken, 1869) (*cinereipennis* Lundstrom, 1912).—Coast: Cascade Head Experimental Forest, May 23, 1948 (F); Gales Creek, September 5, 1948 (F); Gunaldo Falls, June 30, July 14, 1949 (F); High Heaven, June 22, 1945, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Jordan Creek, September 5, 1948 (F); Lake Tahkenitch, August 12, 1948 (F); Neskowin, August 17, 1948 (James); Pacific City, May 23, 1948 (F); Saddle Mt. (Boyer), June 21, July 29, 1934, August 1, 1935 (*Macnab and associates*); Saddle Mountain State Park, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 3, May 23-29, 1946, May 14, July 8, 1947; Sta. 3A, June 24, July 14, 1948 (F). Albrights, Dayton, September 19, 1946 (F); Silver Creek Falls, August 2, 1948, July 8, 1949 (F); Willamette River, below Dayton, April 24, 1949 (F). Southern Oregon: State Line Creek, August 9, 1948 (A & F). Cascades: Mount Hood-Beaver Creek, August 7, 1946 (A); Eagle Creek Forest Reserve, July 1, 1917 (*Melander*); Horsetail Falls, August 9, 1946, July 19, 1947 (A & F); Multnomah Falls, July 19, 1947 (F); Oneonta Gorge, July 19, 1947 (A); Sahale Falls, July 17, 1947, July 31, 1948 (F); Salmon River, July 30, 1948 (F); Still Creek, July 31, 1948 (A & F); Timberline, at 5,000 ft., August 7, 1946 (A); Wahkeena Falls, September 9, 1934 (*Melander*). Cascadia, August 2, 1948 (F); Dell Creek, July 14, 1947 (A); Hazel Creek, July 15, 1947 (A); Odell Lake, July 14, 1947 (A); Salt Creek Falls, August 7, 1948 (A & F). Blue Mts.: Spring Creek, June 26, 1948 (A & Baker).

Limonia (Dicranomyia) humicola (Osten Sacken, 1859) (*badia* of authors, nec Walker, 1848; *viridicans* Doane, 1908).—Coast: Grand Ronde, March 31, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Lee's Camp, September 18-25, 1949 (Davis); Sourgrass Creek, May 17, 1948 (F). Willamette Valley: Peavine, Sta. 1, September 10, 1945, July 3-12, October 11, 1946, July 2, 1948; Sta. 3, April 26, May 16, 1946, May 3-14, 1947, May 11, June 29, 1948 (F). Happy Valley, McMinnville, June 3, 1945, April 14, 1946 (F); Silver Creek Falls, May 9, August 2, 1948, July 8, 1949 (F). Southern Oregon: Store Gulch Forest Camp, August 8, 1948 (A & F). Cascades: Mount Hood-Eagle Creek, August 2, 1921 (*Melander*), July 18, 1947 (F); Horsetail Falls, August 9, 1946, July 19, 1947 (A & F); Multnomah Falls, August 9, 1946, July 19, 1947 (F); Oneonta Gorge, July 19, 1947; Sahale Falls, July 31, 1948 (A); Still Creek, July 31, 1948 (A & F); Viento, August 1, 1921 (*Melander*). Metolius River, August 3, 1948 (A & F). Blue Mts.: Spring Creek, April 24, May 9, 1949 (Baker); Langdon Lake, July 2-3, 1948 (A); Pine Creek, 4,600 ft., June 25, 1948 (A). Wallawas: Lostine Valley Guard Station, June 30, 1948 (A); Wallowa Lake, June 28, 1948 (A).

Certain of the above specimens, particularly those from the gorges along the Columbia River, have the yellow femoral tips much reduced or entirely lacking.

Limonia (Dicranomyia) illustris Alexander, 1944.—Coast: Carlton-Meadow Lake road, June 5, 1942 (*Macnab*), types; High Heaven, May 4, 1947 (F). Willamette Valley: Peavine, Sta. 1, May 5, July 13, 1945, on sword fern, May 18, 1946; Sta. 3A, May 5-24, 1947, June 8, 1948 (F). Happy Valley, McMinnville, May 12, 1946 (F).

Limonia (Dicranomyia) inhabilis Alexander, 1949.—Coast: Three Rivers, May 23, 1948 (F), type. The male hypopygium is shown (Fig. 10).

Limonia (Dicranomyia) iowensis (Rogers, 1926).—Willamette Valley: Willamette River, 2 miles south of Dayton, June 24, 1948 (F). This is the first record of the species from west of the Rocky Mountains.

Limonia (Dicranomyia) libertoides (Alexander, 1912).—Willamette Valley: Peavine, Sta. 1, April 25-May 4, 1945, on sword fern; Sta. 2, May 22, 1948; Sta. 3, April 26, May 16, 1946, May 24, 1947, April 20, 1948; Sta. 4, April 17, 1946 (F). Amity Hills, April 25, 1948 (F); Corvallis, April 18 (*Cole* auct., determined 1920 by Alexander as *stigmata* Doane); Happy Valley, McMinnville, May 12, 1946 (F); Zena, June 5, 1948 (F).

Limonia (Dicranomyia) longipennis (Schummel, 1829) (*immemor* Osten Sacken,

1861).—Willamette Valley: Peavine, without station, July 12, 1945 (F). McMinnville, November 10, 1942, August 28, 1948 (F); Woods Hopyard, Willamette River, July 4, 1947 (F). Southern Oregon: O'Brien, 1,475 ft., August 9, 1948 (A). Cascades: Bend, along Deschutes River, August 5, 1948 (A & F).

Limonia (Dicranomyia) marmorata (Osten Sacken, 1861) (*signipennis* Coquillett, 1905).—Coast: Florence, February 20, 1923 (D. W. Hatch), Oregon State Agricultural College, Accession No. 2,620; Harris Beach State Park, August 11, 1948 (F); Neskowin, August 11-17, 1948 (James), numerous in the intertidal zone. This is a Pacific Coast marine species whose life history has been described by Saunders (Ann. Ent. Soc. America, 21: 521-545; 1928, as *signipennis*).

Limonia (Dicranomyia) melanderiana Alexander, 1945.—Blue Mts.: Langdon Lake, September 9, 1949 (Davis).

Limonia (Dicranomyia) moniliformis (Doane, 1900).—Willamette Valley: Three miles south of Dayton, along the Willamette River, June 3, 1948 (F). Blue Mts.: Juntura, May 20, 1949 (Davis). Wallowas: Enterprise, 3,750 ft., June 29, 1948 (A).

An unfortunate confusion in names has obtained in this particular part of the subgenus, chiefly through the inability to study the male genitalia of certain critical species. I now regard the species formerly called *gibsoni* Alexander, 1929, as being the true *haeretica* Osten Sacken, 1869, widely distributed along the Atlantic coast of North America. It further appears that the paratype females of *moniliformis* from Long Island, New York, and Nantucket Island, Massachusetts, similarly pertain to *haeretica*, as here restricted. As to whether *brunnea* Doane, 1900, likewise falls in the synonymy of *haeretica* is more questionable. All of these species that are represented by female specimens only are difficult to determine. The type of *moniliformis* was from Colorado and represents the species under consideration. It has as a synonym *penicillata* Alexander and numerous inland records reported as being *haeretica*.

Limonia (Dicranomyia) morioides (Osten Sacken, 1860).—Wallowas: Wallowa Lake, 4,410 ft., June 28, 1948 (A).

Limonia (Dicranomyia) nielseniana Alexander, 1949.—Blue Mts.: Spring Creek, 3,900 ft., September 19-October 17, 1948 (Baker). The male hypopygium is shown (Fig. 11).

Limonia (Dicranomyia) particeps (Doane, 1908).—Coast: Coquille River, Sitkum, August 4, 1948 (H. W. Thorne); Grand Ronde, March 31, 1949 (F); High Heaven, July 12, 1949 (F); Jordan Creek, September 5, 1948 (F); Pacific City, May 23, 1948 (F); Sand Lake, April 12, 1949 (F); Three Rivers, May 23, 1948 (F). Willamette Valley: Peavine, June 18, 1948; Sta. 1, July 2, 1948; Sta. 3, July 16, 1946, June 29, 1948; Sta. 3A, March 26, 1946, June 18, 1947, July 24, 1948 (F). Amity Hills, 500 ft., April 25, 1948 (F); Henderson Bridge, June 16, 1948 (F); McMinnville, July 2, 1949 (F); Panther Creek, McMinnville, July 25, 1948 (F); Silver Creek Falls, May 9, August 2, 1948, July 8, 1949 (F). Cascades: Mount Hood-Bear Creek, August 1, 1948 (A & F); Beaver Creek, August 1, 1948 (A & F); Hood River, October 26 (Cole auct.); Oneonta Gorge, August 9, 1946 (A & F). Cascadia, August 2, 1948 (F); Trout Creek Forest Camp, South Santiam, 1,245 ft., August 2, 1948 (A). Blue Mts.: South fork of Walla Walla River, 1,450 ft., July 4, 1948 (A).

Limonia (Dicranomyia) piscataquis Alexander, 1941.—Cascades: Mount Hood, Clear Lake, 3,300 ft., October 7, 1945 (F). This very distinct fly had hitherto been known only from northern Maine.

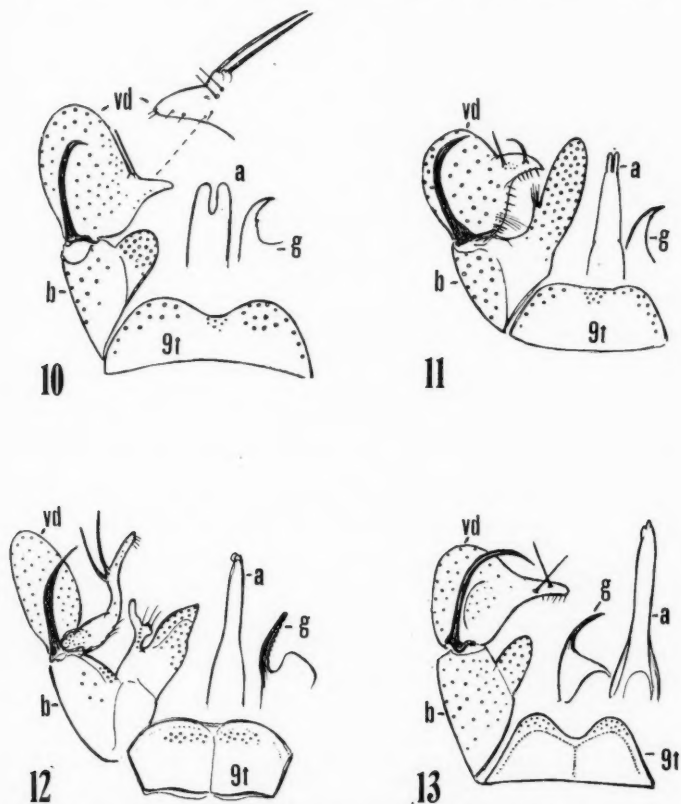
Male hypopygium (Fig. 12) with the tergite, *9t*, transverse, the caudal margin nearly truncate, the surface with a narrow darkened midline; setigerous punctures translucent, conspicuous, setae long and pale. Proctiger undeveloped. Baistyle, *b*, in total area about one-third more extensive than the ventral dististyle; setae of body of style sparse; ventromesal lobe large and complex, stout-based, on outer margin with an irregular blackened area, angularly bent at near midlength and here provided with several strong setae; apex of lobe produced into two outer divisions, the larger one narrowed to a point, the smaller lower division (not shown in figure) more obtuse, both provided with long coarse setae. Dorsal dististyle blackened, gently curved, the outer fourth more narrowed into a long acute point. Ventral dististyle, *vd*, with the main body oval, relatively small; rostral prolongation very loosely joined, appearing as a powerful feebly sclerotized arm that is more enlarged at base, the outer two-thirds more slender and sinuous, the tip obtuse, with a few strong setae; rostral spines borne on outer margin of the narrowed part, unusually long and powerful, considerably longer than the prolongation beyond the point of insertion of the outer one. Gonapophysis, *g*, with mesal-apical lobe long and slender, black-

ened, its lateral edge microscopically toothed or roughened. Aedeagus, *a*, slender, blackened.

Limonia (Dicranomyia) vulgata (Bergroth, 1888) (*ochracea* Doane, 1900).—Willamette Valley: Peavine, Sta. 1, October 1, 1945, June 20, 1946; Sta. 3, July 2, 1946 (*F*). Cascades: Mount Hood-Bear Springs, 3,200 ft., August 8, 1946 (*F*); Still Creek, 3,600 ft., July 16, 1947 (*A*). Big Meadows, North Santiam, 3,460 ft., August 17, 1947 (*Albright*); Tombstone Meadows, South Santiam, August 17, 1947 (*F*). Blue Mts.: Spring Creek, 3,900 ft., July 25, August 29, October 3, 1948 (*Baker*); Langdon Lake, September 9, 1949 (*Davis*); Little Phillips Creek, 2,850 ft., July 3, 1948 (*A*); Pine Creek, June 30, 1949 (*Baker & Sperry*). Wallawas: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (*A*); Lostine Valley, Shady Forest Camp, 5,600 ft., August 19, 1948 (*A*).

Limonia (Dicranomyia) willamettensis Alexander, 1949.—Willamette River, 2 miles south of Dayton, June 24, 1948 (*F*), type. The male hypopygium is shown (Fig. 13).

Limonia (Rhipidia) fidelis (Osten Sacken, 1859).—Blue Mts.: South fork of the



Figs. 10-13.—Male hypopygia: 10. *Limonia (Dicranomyia) inhabilis* Alexander. 11. *L. (Dicranomyia) nielsenii* Alexander. 12. *L. (Dicranomyia) piscataquii* Alexander. 13. *L. (Dicranomyia) willamettensis* Alexander (See fig. 1 for explanation of symbols).

Upper Walla Walla River, below the plant of the Pacific Power and Light Company, 1,450 ft., July 4, 1948 (A).

Limonia (Rhipidia) lecontei Alexander, 1940 (Replacement name for *maculata* Meigen, 1818, preoccupied by *maculata* Meigen, 1804).—Coast: Coquille River, Sitkum, August 5, 1948 (H. W. Thorne); Humbug Mountain State Park, August 11, 1948 (F); Jordan Creek, September 5, 1948 (F); Lee's Camp, September 18-25, 1949 (Davis); Saddle Mt. (Boyer) April 21, June 2, 1934 (*Macnab and associates*). Willamette Valley: Peavine, Sta. 1, June 20, July 26, August 6, 1946; Sta. 2, May 6, 1947; Sta. 3A, May 4, 1945, on sword fern, July 16, August 30, September 10, 1948; Sta. 4, April 19, 1947 (F). McMinnville, May 24, 1947, May 26-30, June 7, 1948 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F). Cascadia, August 2, 1948 (F). Blue Mts.: Spring Creek, 3,900 ft., August 18-20, September 19, 1948, July 31, 1949 (Baker). Wallawas: Above the Lazy T Ranch, 5,000 ft., July 9, 1949 (Sperry); Lostine, 3,375 ft., July 2, 1948 (A).

Limonia (Discobola) annulata (Linnaeus, 1758) (*argus* Say, 1824; *imperialis* Loew, 1851).—Wallawas: Lazy T Ranch, 4,500 ft., August 26, 1949 (G. H. Sperry).

Limonia (Discobola) neolegans nom. nov. (for *elegans* Doane, Journ. N. Y. Ent. Soc., 8: 186, 1900; nec *elegans* Zetterstedt, Ins. Lapponica, Diptera, p. 837, 1838; nec *elegans* Wiedemann, Aussereur. zweifl. Ins., 2: 617, 1830).—Coast: Chetco River, August 11, 1948 (F); Gualdo Falls, June 30, July 14, 1949 (F); High Heaven, June 22, 1945, August 6, 1946, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Saddle Mt. (Boyer), July 21, 1935 (*Macnab and associates*); Saddle Mountain State Park, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 1, June 10, July 3, 1946, May 15-27, 1947; Sta. 2, May 20, June 18, 1946; Sta. 3, June 9-25, 1948, July 2, 1949; Sta. 3A, May 29, 1947, June 2, 1948 (F). Hendersons Bridge, May 22, 1947 (F); Silver Creek Falls, August 2, 1948 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (A & F); Beaver Creek, 1,150 ft., August 7, 1946 (A & F). House Rock Forest Camp, August 3, 1948 (A & F).

I am greatly indebted to Dr. Alan Stone for information and suggestions regarding the synonymy of the present fly and various other names that are preoccupied in the Tipulidae.

Antocha (Antocha) monticola Alexander, 1917.—Coast: Humbug Mountain State Park, August 11, 1948 (F); Jordan Creek, September 5, 1948 (F); Lee's Camp, September 18-25, 1949 (Davis). Willamette Valley: Silver Creek Falls, July 8, 1949 (F). Cascades: Mount Hood-Horsetail Falls, August 9, 1946, July 19, 1947 (A & F); Oneonta Gorge, August 9, 1946, July 19, 1947 (A & F), both sexes resting and bobbing on cliff faces but not ovipositing. Cascadia, August 2, 1948 (A & F); Deschutes River Guard Station, 4,635 ft., August 6, 1948 (A); Little Deschutes River, August 4, 1946 (A); Metolius River, June 14, 1945, June 15, 1947, August 3, 1948 (F); Odell Lake, 4,760 ft., August 6, 1948 (A); Rivers Edge Forest Camp, Willamette River, August 5, 1946 (A); Schweitzer Creek, Willamette River, August 5, 1946 (A). Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F). Wallawas: Johnson Park, Wallowa River, 2,750 ft., August 18-20, 1948 (A); Lazy T Ranch, 4,500 ft., August 24-31, September 3-10, 1949 (Sperry).

Elliptera astigmatica Alexander, 1912.—Coast: Gualdo Falls, June 6, 1949 (F); Marys Peak, June 1, 1946 (F). Willamette Valley: Silver Creek Falls, 950 ft., August 2, 1948 (A & F), July 8, 1949 (Davis). Cascades: Mount Hood-Multnomah Falls, August 9, 1946, July 19, 1947 (A); Sahale Falls, July 17, 1947, July 31, 1948 (A & F); Tilly Jane Creek, 5,600 ft., July 29, 1948 (A). North Santiam Highway, May 30, 1949 (F); Salt Creek Falls, 3,800 ft., July 14, 1947 (A), August 7, 1948 (F). Crater Lake-Vidaie Falls, 6,500 ft., August 2, 1946 (A).

Dicranoptycha melampygia Alexander, 1949.—Coast: High Heaven, July 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, July 3-18, 1946, June 19-24, 1947; Sta. 2, July 1, 1948 (F). Baker Creek Valley, McMinnville, June 14-30, 1948 (F); McMinnville, June 14-30, 1948 (F); Zena, Eola Hills, June 5, 1948 (F), type material. Cascades: Mount Hood-Hood River Meadows, 4,500 ft., July 17, 1947 (F).

Dicranoptycha nigrogenualis Alexander, 1949.—Coast: Saddle Mountain State Park, July 24, 1949 (F). Cascades: Mount Hood-Sahale Falls, 4,575 ft., July 17, 1947 (A), part of type material. Blue Mts.: Little Phillips Creek, 4,000 ft., July 3, 1948 (A).

Dicranoptycha quadrivittata Alexander, 1919.—Wallawas: Wallowa Lake, July 2,

1949 (Sperry); trail above Lazy T Ranch, 5,000 ft., July 6, 1949 (Sperry). A characteristic Rocky Mountain species.

Dicranoptycha spinosissima Alexander, 1949.—Blue Mts.: Little Phillips Creek, near Elgin, 2,850 ft., July 2, 1948 (A); part of type material.

Dicranoptycha stenophallus Alexander, 1949.—Coast: Humbug Mountain State Park, August 11, 1948 (F). Willamette Valley: Peavine, Sta. 1, June 20, July 26, August 6, 1946, July 3, 1947; Sta. 2, May 20, August 20, 1946, July 11-12, 1945; Sta. 3, July 21, August 13, September 13, 1946; Sta. 3A, July 14-16, 1948 (F), part of type material. Happy Valley, McMinnville, August 6, 1946 (F); Panther Creek, McMinnville, July 25, 1948 (F); Forest Grove, July 8-12 (Cole), determined 1920 by Alexander as *sobrina* Osten Sacken, in error; Independence, July 6, 1934 (N. P. Larson); Silver Creek Falls, August 1, 1948 (A & F), very numerous in open woods above falls. Southern Oregon: O'Brien, August 9, 1948 (A & F); State Line Creek, August 9, 1948 (A & F). Cascades: Mount Hood-Cloud Cap Inn Junction, August 9, 1946 (F); Eagle Creek, 3,700 ft., July 13, 1947 (A); Hood Rapids at 3,000 ft., July 29, 1921 (Melander); Horsetail Falls, August 9, 1946 (A & F). Blue Mts.: Langdon Lake, 4,995 ft., August 17, 1948 (A); Little Phillips Creek, above Elgin, 2,850 ft., July 2, 1948 (A), part of type material.

PEDICINI

Ula (Ula) elegans Osten Sacken, 1869.—Willamette Valley: Silver Creek Falls, 1,000 ft., May 9, 1948 (F).

Ula (Ula) paupera Osten Sacken, 1869.—Coast: Agate Beach, March 27, 1949 (F); High Heaven, August 6, 1946, April 1, July 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, July 2, 1948 (F). Cascades: Mount Hood, Salmon River, July 30, 1948 (F). Lost Prairie, 3,700 ft., August 3, 1948 (F); Metolius River, 2,800 ft., August 3, 1948 (A); Odell Lake, 4,760 ft., August 6, 1948 (F); Salt Creek Falls, 3,800 ft., August 7, 1948 (F). Blue Mts.: Spring Creek, June 24-26, August 20-29, 1948 (Baker); Langdon Lake, 4,970 ft., July 3, 1948 (A).

Orniathodes harimani Coquillett, 1900.—Cascades: Salt Creek Falls, 3,800 ft., August 7, 1948 (F).

Pedicia (Pedicia) magnifica Hine, 1903 (as *Peditia*).—Cascades: Mount Hood, taken by H. K. Morrison, in the Bigot Collection (Osten Sacken, 1895). Crater Lake-Cold Springs Forest Camp, 5,900 ft., at light, August 7, 1948 (F); Pole Bridge Meadow, 5,900 ft., August 11, 1935 (George Ferguson). Fort Klamath, August 16, 1922 (L. R. Dice); University of Michigan.

Pedicia (Pedicia) obtusa Osten Sacken, 1877.—Willamette Valley: Peavine, Sta. 3A, September 10, 1948 (F). Hitherto from California. Part of the male hypopygium is shown (Fig. 14).

Pedicia (Pedicia) parvicellula Alexander, 1938.—Coast: Lee's Camp, September 18-25, 1949 (Davis); Saddle Mt. (Boyer), September 26, 1936 (Macnab); Tillamook, September 19-21, 1949 (Davis). Cascades: Mount Hood-Hood River Meadows, 4,500 ft., July 31, 1948 (F); Horsethief Meadows, 3,400 ft., August 9, 1946 (F); Robin Hood Forest Camp, 3,560 ft., August 9, 1946 (Macnab); Still Creek, 3,600 ft., July 31, 1948 (A & F). Metolius River, at Lower Bridge Forest Camp, 2,600 ft., August 3, 1948 (A & F); Odell Lake, Lazy Creek, 4,800 ft., August 4, 1946 (A); Tombstone Meadows, South Santiam, August 17, 1947 (F). Crater Lake-Pole Creek Meadows, 5,900 ft., August 2-4, 1946 (A), August 8, 1948 (A & F); smaller than the typical form and require further study and comparisons. Blue Mts.: Spring Creek, 3,900 ft., August 29, 1948 (Baker).

Pedicia (Tricyphona) ampla (Doane, 1900).—Willamette Valley: Peavine, Sta. 1, October 3, 1945; Sta. 2, September 12, October 5, 1946; Sta. 3, September 11, 1948; Sta. 3A, September 18, 1945, September 10, 1948 (F). Corvallis, September 21-25, 1905; Forest Grove, May 5, October 3 (Cole).

Pedicia (Tricyphona) aperta (Coquillett, 1905).—Coast: High Heaven, May 4, 1947 (F). Willamette Valley: Peavine, Sta. 3A, October 18, 1946, May 12, 1947 (F). Silver Creek Falls, August 2, 1948 (A & F), July 8, 1949 (F). Cascades: Mount Hood-Bear Creek, August 1, 1948 (A & F); Hood River, June 8 (Cole); Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F); Horsetail Falls, 100 ft., July 19, 1947 (A & F); Horsethief Meadows, 3,400 ft., July 18, 1947 (F); Robin Hood Forest Camp, 3,560 ft., August 8, 1946 (F); Still Creek, 3,600 ft., October 6, 1945, July 16, 1947 (F); Stream below timberline, 5,000 ft., July 16, 1947 (A). Des-

chutes River Guard Station, 4,635 ft., August 6, 1948 (A); Dutchman's Flat, Century Drive, 6,100 ft., August 5, 1948 (A & F); Odell Lake, 4,760 ft., August 6, 1948 (F); Salt Creek Falls, 3,800 ft., July 14, 1947 (MMA); Sparks Lake, 5,450 ft., August 5, 1948 (A); Summit Lake, Willamette Pass, 5,120 ft., August 7, 1948 (A); Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Crater Lake-Annie Springs, 6,000 ft., August 1, 1946 (A); Pole Creek Meadows, 5,900 ft., July 12, 1947, August 7, 1948 (A & F). Eastern Oregon: Seneca, Malheur National Forest, June 12, 1947 (F); Ochoco National Forest, June 14, 1947 (F). Blue Mts.: Spring Creek, 3,900 ft., June 25, August 29, September 12, 1948 (Baker); Little Phillips Creek, 4,000 ft., July 3, 1948 (A); Whitney, June 19, 1949 (Baker). Wallawas: Aneroid Lake trail, 7,000 ft., July 26, 1949 (Baker); Wallowa Creek, spring at Power Plant, 4,675 ft., June 29, 1948 (A).

Pedicia (Tricyphona) bicomata Alexander, 1943.—Coast: Bald Mt., July 19, 1942 (F); Lee's Camp, September 18-25, 1949 (Davis); Seaside, August 7, 1940 (Townes), type. Willamette Valley: Peavine, Sta. 1, May 18, July 26, 1946; Sta. 3, May 16, June 4, July 16, September 13, 1946, May 3-20, July 8, September 3, 1947, May 25, June 29, 1948, July 2, 1949; Sta. 3A, May 16, July 11, September 10, October 12, 1945, May 21, July 5, September 17, October 1, 1946, May 5-29, 1947, May 12, June 2, August 30, September 13, 1948 (F). Silver Creek Falls, 800 ft., August 2, 1948 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., July 16, 1947, August 1, 1948 (A & F); Beaver Creek, August 7, 1946 (A & F); Eagle Creek, August 2, 1921 (Melander); Hood River, June 30, 1917 (Melander); Hood River Meadows, July 17, 1947 (A); Horsethief Meadows, July 18, 1947 (Macnab); Multnomah Falls, August 9, 1946, July 19, 1947 (A); Still Creek, July 16, 1947, July 31, 1948 (F); Stream below timberline, 5,000 ft., July 16, 1947 (A). Lost Prairie, 3,700 ft., August 3, 1948 (A & F); Metolius River, 2,200 ft., June 15, 1947, August 3, 1948 (F); North Santiam, May 30, 1949 (F); Odell Lake, 4,760 ft., August 6, 1948 (A); Salt Creek Falls, August 7, 1948 (F); Tombstone Meadows, South Santiam, August 17, 1947 (Albright); Willis Creek, North Santiam, August 17, 1947 (F).

Male hypopygium (Fig. 17) with the ninth tergite, 9t, transverse, the caudal margin with a broad U-shaped notch, the much broader lobes very densely provided with short erect setulae, with strong pale setae back from the margin. Basistyle, b, at apex produced into an elongate lobe, narrowed to the obtuse tip, the apex back for about one-half the length of the lobe with conspicuous retrorse spines; mesal face of style near base with a brush of long yellow setae. Interbase, i, a powerful simple rod, stout-based, angularly bent at near one-third the length, thence produced into a long straight spine. Dististyle, d, elongate, tapering gradually to the obtuse tip, on outer margin at base with a powerful curved spine that is about as long as the style beyond the point of insertion. Phallosome, p, with the aedeagus weak but relatively slender, fully twice the length of the subtending apophyses, the latter obtusely rounded at tips.

Pedicia (Tricyphona) cascadenis sp. nov.—General coloration dark brownish gray, the praescutum with three scarcely differentiated darker stripes; antennae (male) 16-segmented, elongate, approximately two-thirds as long as the wings; halteres unusually long and slender; wings with a weak brownish tinge, stigma slightly darker; cell M_1 closed or open by the atrophy of m ; male hypopygium with the apex of basistyle flattened and scooplike; dististyle divided into two long conspicuous arms.

♂. Length, about 7.5-8 mm.; wing 7.5-8.5 mm.; antenna, about 5.5-5 mm.

Rostrum brownish gray; palpi brownish black. Antennae (male) 16-segmented, elongate, approximately two-thirds the length of the wing; flagellar segments elongate-cylindrical, the outer ones gradually shorter, terminal segment about one-half the penultimate; verticils short, about one-fourth to one-fifth the segments, placed beyond the middle of their length; segments with a short dense erect pubescence, additional to the verticils. Head dark brownish gray; vertex broad.

Thorax dark brownish gray, the praescutum with three scarcely differentiated darker stripes; dorsopleural region dusky. Halteres unusually long and slender, stem obscure yellow, knob infuscated. Legs with the coxae brown, pruinose; trochanters obscure yellow; remainder of legs brownish black, the femoral bases restrictedly obscure yellow, even more limited on the posterior legs. Wings (Fig. 15) with a weak brownish tinge, the oval stigma slightly darker brown; veins dark brown. Venation: R_s long, reaching its maximum length in the holotype, arcuated to weakly angulated at origin; cell R_4 from one-fourth to one-fifth longer than its petiole; cell M_1 closed or open by the atrophy of m (closed in the holotype, as figured); $m-cu$ at or a short distance beyond the fork of M .

Abdominal tergites and hypopygium dark brown, the more proximal sternites obscure yellow, the outer ones darker. Male hypopygium (Fig. 18) with the basistyle, *b*, short and compact, the outer portion beyond the dististyle produced into a very thin scooplike blade, with a shorter flattened arm immediately beyond the dististyle. Interbase, *i*, a stout straight rod, its tip acute. Dististyle, *d*, with two very long conspicuous arms, the outer more flattened and subultrate in outline.

Holotype, ♂, Hood River, Mount Hood, 4,480 ft., August 8, 1946 (C. P. Alexander). *Paratopotypes*, 3 ♂♂, July 31, 1948 (C. P. Alexander); *paratypes*, 4 ♂♂, Island Lake, Beartooth Mts., along the Cooke-Red Lodge Highway, Wyoming, about 9,000 ft., July 10, 1946 (M. E. Smith).

Pedicia (Tricyphona) cascadenis is readily told from all other regional species by the elongate antennae of the male and the distinctive hypopygium. In its venation, it is most similar to *P. (T.) glacialis* (Alexander), which differs in the short antennae and in the very different male hypopygium.

Pedicia (Tricyphona) constans (Doane, 1900).—Coast: Pacific City, May 23, 1948 (F); Sourgrass Creek, May 17, 1948 (F); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 1, May 11-18, 1946, May 24, 1947; Sta. 2, May 31, 1946; Sta. 3, March 9, April 22, 1946, March 12, May 3-30, 1947; Sta. 3A, October 3-23, November 8, 1945, October 1, 1946, May 5-29, June 30, 1947, May 17-24, June 2-8, September 10, 1948, May 6, 1949 (F). Clackamas County, May 15, 1946 (J. F. Bock); Forest Grove, March 29 (Cole); Happy Valley, McMinnville, April 14, 1946 (F); Portland, 1927 (E. Walley Jones). Cascades: Mount Hood-Bear Creek, August 1, 1948 (F); Hood River Meadows, July 31, 1948; Horsethief Meadows, August 9, 1946 (F); Miltnonah Falls, August 9, 1946 (A & F); Still Creek, July 16, 1947 (A). Lost Prairie, 3,700 ft., August 3, 1948 (A & F); Metolius River, 2,600 ft., August 3, 1948 (A & F). Crater Lake-Pole Creek Meadows, August 7, 1948 (F). Blue Mts.: Spring Creek, 3,900 ft., June 25, July 25, August 20-22, 1948, June 10-30, 1949 (Baker). Wallows: Wallowa Lake, July 3, 1949 (Sperry).

Male hypopygium (Fig. 19) with the tergite, *9t*, transverse, the caudal margin very shallowly triemarginate, there being a very shallow median lobe and variously developed sublateral lobes that are further separated from the still more lateral pair of lobes by even more shallow notches; apex of central part of tergal margin microscopically setulose. In the lower figure, a variation in the tergal outline is shown. Basistyle, *b*, with the apical lobe very slender, with relatively few blackened spines, chiefly on the mesal face; at base of the lobe with a more flattened reddish plate that is extended into a subacute point, the surface with abundant dense pale setulae. Interbase, *i*, complex, produced into a slender curved spine with a small lobule on outer margin near base; surrounding the interbase a darkened lobe bearing a brush of unusually long yellow setae. Dististyle, *d*, chiefly bilobed, the outer lobe with long erect yellow setae, the inner lobe at apex bearing two stout blackened spines. Phallosome, *p*, with the aedeagus straight, weak, jutting slightly beyond the apices of the gonapophyses.

Pedicia (Tricyphona) degenerata (Alexander, 1917).—Cascades: Crater Lake-Annie Springs, 6,000 ft., August 1, 1946 (A). Wallows: Aneroid Lake trail, 7,000 ft., July 26, 1949 (Baker); Eagle Cap Wilderness Area, 5,000 ft., June 28, 1948 (A); Lostine Valley, 5,500 ft., August 19, 1948 (MMA).

Pedicia (Tricyphona) diaphana (Doane, 1900).—Coast: Grand Ronde, March 31, 1949 (F); Saddle Mt. (Boyer), April 27, 1935 (Macnab). Willamette Valley: Peavine, Sta. 1, May 22, 1947; Sta. 3, March 9, May 29, 1946, March 17, April 11, May 7-20, 1947; Sta. 3A, May 5, 1947, June 8, 1948 (F). Cascades: Mount Hood-Hood River Meadows, July 17, 1947, July 31, 1948 (A & F). Metolius River, June 14, 1945, June 15, 1947, August 3, 1948 (F). Blue Mts.: Spring Creek, 3,900 ft., September 5-19, 1948, May 9, 1949 (Baker); Balloon Tree trail, 5,000 ft., July 3, 1948 (A). Wallows: Lostine Valley, 5,000 ft., July 1, 1948 (A).

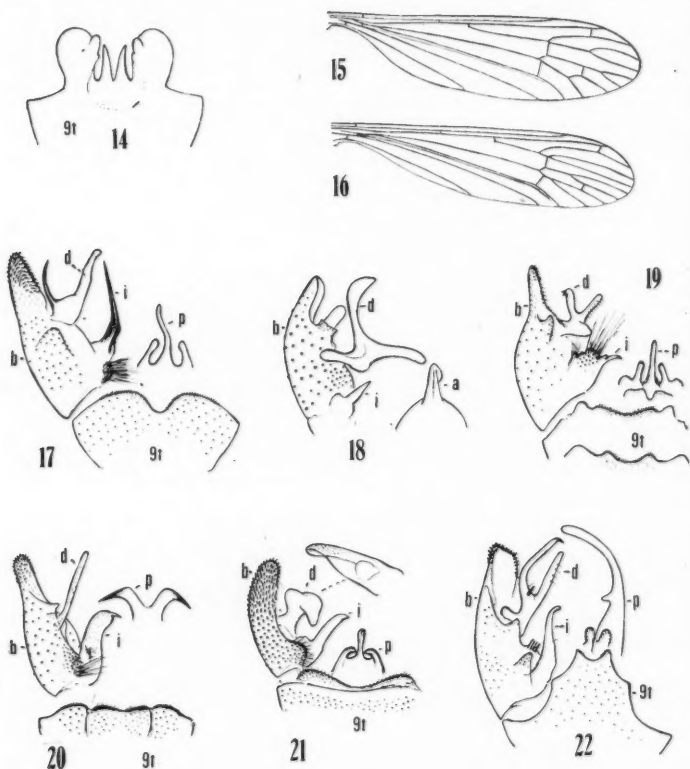
Pedicia (Tricyphona) fenderiana sp. nov.—Thorax dull black, the pleura somewhat more pruinose; antennae short; halteres elongate; wings weakly grayish yellow, the stigma and a seam along vein *Cu* faintly darker; cell *R*₄ sessile or short-petiolate, cell *1st M*₂ long; male hypopygium with the basistyle produced into a slender lobe that is provided with numerous blackened pegs; interbase a stout flattened blade, narrowed at tip into a daggerlike point, the surface with microscopic setulae; dististyle a long slender rod; phallosome consisting of two divergent horns.

♂. Length, about 8.5-9 mm.; wing, 9.5-10 mm.; antenna, about 0.8-0.9 mm.

Rostrum and palpi black. Antennae short, black throughout; flagellar segments oval, shorter than the verticils. Head brownish black, sparsely pruinose; vertex broad.

Thorax dull black, the pleura somewhat more pruinose. Halteres elongate, stem dirty white, clearer at base, knob infuscated. Legs with the fore coxae obscure yellow, restrictedly darkened at base, remaining coxae dark brown, pale at tips; trochanters yellow; remainder of legs black, the femoral bases restrictedly yellow. Wings (Fig. 16) with a weak grayish yellow ground, the stigma very pale brown, inconspicuous; a poorly indicated dusky seam along vein *Cu*; wing base more yellowed. Venation: *Rs* relatively long, angulated and weakly spurred at origin; *r-m* at fork of vein R_{4+5} , cell R_4 thus sessile or short-petioled; cell 1st *M*, long, *m* subequal to or much shorter than the basal section of *v*. in *M*,; *n-cu* at or beyond the fork of *M*.

Abdomen elongate, brownish black to black, including the hypopygium. Male hypopygium (Fig. 20) with the tergite, 9t, transverse, the caudal margin truncated, more or less trilobed, the lateral lobes with the margins narrowly thickened and darkened; median area broader, emarginate at midline, the border darkened and setiferous; no developed



Figs. 14-22.—14. *Pedicia (Pedicia) obtusa* Osten Sacken, male hypopygium, ninth tergite. 15-16. Venation: 15. *Pedicia (Tricyphona) cascadenensis* sp. nov. 16. *Pedicia (Tricyphona) fenderiana* sp. nov. 17-22. Male hypopygia: 17. *P. (Tricyphona) bicornata* Alexander; 18. *Pedicia (Tricyphona) cascadenensis* sp. nov. 19. *P. (Tricyphona) constans* Doane. 20. *P. (Tricyphona) fenderiana* sp. nov. 21. *P. (Tricyphona) glacialis* Alexander. 22. *P. (Tricyphona) macrophallus* Alexander (See fig. 1 for explanation of symbols).

lateral tergal arms. Basistyle, *b*, produced apically into a slender lobe that is set with numerous blackened peglike spinous setae; at its base and near the origin of the dististyle with a small short fingerlike lobule; mesal face of basistyle near proximal end with a group or brush of unusually long setae; setae of outer surface of style long and conspicuous. Interbase, *i*, a stout flattened blade, the tip obtuse, abruptly produced into a daggerlike point; surface of blade with small setae, these very numerous and congested near apex; nearer base with a concentration of longer setae. Dististyle, *d*, a long slender parallel-sided rod, its tip obtuse, the surface with scattered microscopic pale punctures. Phallosome, *p*, consisting essentially of two divergent horns that narrow into strong spines.

Holotype, ♂, in poor condition, Sourgrass Creek, Yamhill Co., in Coast Range, May 17, 1948 (K. M. Fender). *Paratopotypes*, 4 ♂♂.

This unusually interesting species is named for the collector, Kenneth M. Fender, student of the Nearctic fireflies, particularly the difficult *Malthodes* complex. The nearest ally is *Pedicia* (*Tricryphona*) *unigera* Alexander, which differs in the coloration, venation and structure of the male hypopygium.

Pedicia (*Tricryphona*) *glacialis* (Alexander, 1917).—Coast: Saddle Mt., Hood Craven Cabin, 3,000 ft., September 30, 1933 (Macnab). Cascades: Mount Hood-One mile south of the Wapinitia cut-off junction, August 7, 1946 (F). Tombstone Meadows, South Santiam, August 17, 1947 (F).

Male hypopygium (Fig. 21) having the ninth tergite, *9t*, with what appears to be a loosely attached narrow posterior border that is densely setiferous, easily torn or broken from the main body of the tergite behind it. Basistyle, *b*, produced beyond the point of insertion of the dististyle as a stout lobe, the entire outer portion densely set with long blackened spicules which pass into stout setae more based on main body of style; mesal face of style with a low lobe that is abundantly setiferous. Interbase, *i*, a flattened cultriform blade, in some specimens appearing narrower than in others, this possibly due to tilting. Dististyle, *d*, a simple dusky, very broad based blade that narrows to an obtuse point, before midlength with a lacuna or clear space, in most specimens the apex of the style beyond this point more bent or pendant. Phallosome, *p*, with the aedeagus relatively small, projecting beyond the incurved apices of the gonapophyses.

Pedicia (*Tricryphona*) *macrophallus* *macrophallus* Alexander, 1945.—Coast: Humbug Mountain State Park, August 11, 1948 (F); wings slightly more patterned than in the type, approaching the race *actaeon*; Meadow Lake, June 6, 1948 (Albright). Willamette Valley: Silver Creek Falls, June 23, 1939 (Aitken & Bohari), type; August 2, 1948 (A). Cascades: Hazel Creek, near Dexter, 990 ft., August 5, 1946, July 15, 1947 (A).

Male hypopygium (Fig. 22) very large. Ninth tergite, *9t*, large, produced and narrowed outwardly, the caudal end relatively narrow, emarginate. Basistyle, *b*, large, the apex produced beyond the point of insertion of the dististyle as a flattened blade, the apex and margin of which bears numerous small black spicules; nearer base of style and close to the interbase with a conical lobe bearing several long yellow setae. Interbase, *i*, a simple elongate rod, the part of the basistyle near its base with a group of four stout black spines. Dististyle, *d*, deeply bilobed, each lobe a long slender arm, the outer somewhat shorter, its tip obtuse, the margin with relatively few erect pale setae; inner arm longer, more sinuous, terminating in a single strong black spine; at base of fork of the style with one further spine. Phallosome, *p*, with the aedeagus unusually large and conspicuous, appearing as a stout, gently curved rod, the apex a little expanded, obtuse, the margin at near midlength bearing a slender lobe; what appear to represent the gonapophyses are oval flattened plates at the base of the aedeagus.

Pedicia (*Tricryphona*) *macrophallus* *actaeon* Alexander, 1947.—Coast: High Heaven, May 4, 1947 (F); Humbug Mountain State Park, August 11, 1948 (F). Southern Oregon: State Line Creek, August 9, 1948 (A & F). The type, from coastal northern California, is even larger than the present materials but has the same conspicuously patterned wings, giving an appearance quite distinct from that of the typical form.

Pedicia (*Tricryphona*) *protea* (Alexander, 1918).—Coast: Agate Beach, March 27, 1949 (F); Cascade Head Experimental Forest, May 23, 1948 (F); Castle Rock, March 31, 1949 (F); Coquille River, Sitkum, August 5, 1948 (H. W. Thorn); Gualdo Falls, May 17, 1948, May 13, June 6, 1949 (F); Hemlock, April 5, 1949 (F); High Heaven, May 4, 1947 (F); Saddle Mt. (Boyer), May 6, October 12, 1934, March 17, May 19, 1935, April 18-25, 1936 (Macnab and associates); Sand Lake, April 12, 1949; Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 1, July 3, 1947; Sta. 3, March 21, April 12, 1946, May 3-15, 1947, June 4, 1948, May 26, 1949; Sta. 3A, May 3, 1946, May 12, 1947, May 6, 1949 (F). Happy Valley, McMinnville, April 14, 1946 (F); Silver Creek Falls, May 9, 1948 (F), May 2, 1949 (F & Davis). Cascades:

Mount Hood-Beaver Creek, 1,150 ft., July 16, 1947 (F); stream below timberline, 5,000 ft., July 16, 1947 (A). North Santiam, May 30, 1949 (F); Odell Lake, along various small streams flowing into the lake from the north, July 13, 1947 (A). Wallows: Lostine Valley Guard Station, 4,900 ft., June 30, 1948 (A); Wallowa Creek, spring at Power Plant, 4,630 ft., June 30, 1948 (A).

Pedicia (Tricyphona) septentrionalis septentrionalis (Bergroth, 1888) (*sparsipuncta* Alexander, 1920).—Coast: Sand Lake, April 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, October 3, 1945; Sta. 3, April 12, May 5, October 11, 1946; Sta. 3A, October 1, 1946 (F). Corvallis, May 14, 1917 (*Moulton*); Hillsboro, April 1, 1919 (*Cole*), types of *sparsipuncta*; McMinville, April 14, 1945, at light (F). Cascades: Prospect, May 28, 1921 (*Dyar*).

Pedicia (Tricyphona) septentrionalis vitripennis (Doane, 1900).—Coast: Lee's Camp, September 18-25, 1949 (*Davis*); Saddle Mt. (Boyer), October 10, 1936 (*Macnab*). Willamette Valley: Peavine, Sta. 3, May 3-30, 1947; Sta. 3A, April 12, May 21, 1946, May 24, 1948 (F). Summit, 650 ft., June 5, 1929 (*Scullen*). Cascades: Prospect, May 28, 1921 (*Dyar*). This is evidently only a color form of *septentrionalis* with the wings unpatterned or virtually so.

Pedicia (Tricyphona) smithae Alexander, 1941.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F); North fork of Iron Creek, 4,400 ft., July 30-31, 1948 (A & F); Sahale Falls, 4,575 ft., July 17, 1947, July 31, 1948 (A & F); Still Creek, July 16, 1947 (F); Stream below timberline, 5,000 ft., July 16, 1947 (A); Tilly Jane Creek, 5,600-5,700 ft., July 18, 1947, July 29-30, 1948 (A & F). Crater Lake-South Rim, 7,100 ft., August 1, 1930 (*Scullen*); Castlecrest Garden, 6,800 ft., August 2, 1946 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker).

Pedicia (Tricyphona) townesiana townesiana Alexander, 1942.—Cascades: Mount Hood-Multnomah Falls, August 9, 1946 (F); Robin Hood Forest Camp, 3,560 ft., in wet swale, July 17, 1947 (A). Salt Creek Falls, August 7, 1948 (A).

***Pedicia (Tricyphona) townesiana majuscula* subsp. nov.—**

♂. Length, about 11 mm.; wing, 11 mm.

♀. Length, about 12-14 mm.; wing, 11.5-12.8 mm.

Very similar to the typical form, differing almost solely in the unusually large size.

At first sight this appears to represent an entirely distinct species but a careful comparison fails to reveal any significant differences except the above, which is very striking.

Holotype, ♂ on slide, Lee's Camp, Coast Range, September 18, 1949 (*J. E. Davis*). *Allotopotype*, ♀ on slide. *Paratopotype*, a ♀ on slide; paratype, ♀, Jordan Creek, Coast Range, September 5, 1948 (*K. M. Fender*).

Pedicia (Tricyphona) unigera Alexander, 1949.—Coast: Gualdo Falls, June 6, 1949 (F); Harris Beach State Park, August 11, 1948 (F). Southern Oregon: State Line Creek, August 9, 1948 (A). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F); Still Creek, 3,600 ft., July 16, 1947, July 31, 1948 (F); Stream below timberline, 5,000 ft., July 16, 1947 (A). Big Meadows, North Santiam, 3,460 ft., August 17, 1947 (F); Hazel Creek, 990 ft., August 5, 1946 (A), type; Lost Prairie, 3,700 ft., August 3, 1948 (A); North Santiam Highway, May 30, 1949 (F); Salt Creek Falls, 3,700 ft., August 7, 1948 (F).

Dicranota (Dicranota) argentea Doane, 1900 (*montana* Alexander, 1920).—Willamette Valley: Peavine, Sta. 2, March 13, 1947 (F). Cascades: Metolius River, June 14, 1945 (F).

***Dicranota (Dicranota) astigma* sp. nov.**—General coloration gray, the praescutum with three entire brownish gray stripes; antennae short in both sexes, 12-segmented; apex of knob of halteres infuscated; wings subhyaline, the stigma only a trifle darker than the ground; R_5 and the supernumerary crossvein widely separated; cell R_6 very short-petiole to barely sessile, m lacking; male hypopygium with the caudal border of the tergite gently emarginate, the lateral arms long and narrow, their tips decurved into sharp points; interbase a long pale blade, the apex obtuse; dististyle nearly as long as the inner apical lobe of basistyle, the tip broadly rounded.

♂. Length, about 5.3-5.5 mm.; wing, 7-7.3 mm.; antenna, about 0.8-0.9 mm.

♀. Length, about 6-7 mm.; wing, 7.2-8.3 mm.

Rostrum gray; palpi dark brown. Antennae 12-segmented, black, the scape more pruinose; flagellar segments oval, the terminal one about one-half longer than the penulti-

mate and apparently formed by the fusion of two segments. Head brownish gray, the anterior part somewhat clearer gray.

Pronotum gray, more infuscated medially. Mesonotum gray, the praescutum with three darker brownish gray stripes, the median one entire; scutal lobes weakly darkened. Pleura gray. Halteres pale, apex of knob infuscated. Legs with the coxae pale, pruinose; trochanters obscure yellow; remainder of legs brown, the outer tarsal segments darker. Wings (Fig. 23) subhyaline, the extreme base more yellowed; stigma only a trifle darker than the ground; veins brown. Venation: Sc_1 ending a short distance beyond the supernumerary crossvein in Cell R_1 , the latter widely separated from vein R_2 , so that the second section of R_{2+3} is approximately three times the first section or about one-fifth longer than R_5 ; cell R_3 usually sessile but in cases with a short element R_{2+3+4} ; R_5 in cases strongly angulated beyond origin.

Abdomen dark brown, in female with the genital segment more obscure yellow. Ovipositor with cerci horn-yellow, long and powerful, gently upcurved. Male hypopygium (Fig. 27) with the caudal border of the tergite, $9t$, gently emarginate, the lateral arms relatively long and narrow, the slightly dilated triangular head decurved into a sharp point; surface of tergite with abundant setae. Basistyle, b , with the outer apical lobe stout, with relatively few setae, all long and slender, the somewhat smaller inner lobe with numerous blackened spinous setae. Interbase, i , a long pale blade, the outer end moderately dilated, the apex obtuse. Dististyle, d , nearly as long as the inner apical lobe of the basistyle, the tip broadly rounded. Phallosome, p , a compact mass, the apex of the darkened aedeagus jutting slightly beyond the level of the apophyses, the latter acute, directed laterad.

Holotype, ♀, Mount Hood, at timberline, 5,500 ft., August 7, 1946 (C. P. Alexander). *Allotype*, ♂, Sahale Falls, 4,575 ft., July 31, 1948 (C. P. Alexander). *Paratypes*, 2 ♂♂, with the allotype; ♀, Horsethief Meadows, 3,400 ft., July 18, 1947 (K. M. Fender).

The most similar species is *Dicranota* (*Dicranota*) *tetonica* Alexander, of the north-central Rocky Mountains, which differs in the details of structure of the male hypopygium, particularly the lateral arms of the tergite, interbase and dististyle.

***Dicranota* (*Dicranota*) *parvella* sp. nov.**—Size very small (wing, male, 4.5 mm.); general coloration brownish gray, the praescutum with a median brown stripe; wings subhyaline, stigma pale brown, inconspicuous; R_{2+3+4} fully one-half the basal section of R_{2+3} ; cell M_1 present; male hypopygium with the median region of tergite only moderately convex, lateral tergal arms long; interbase a large and conspicuous blade, its inner apical angle produced into a long spinous point; basistyle terminating in two unequal lobes.

♂. Length, about 4 mm.; wing, 4.5 mm.

Rostrum and palpi black. Antennae short, black; flagellar segments oval. Head dark brown.

Mesonotum chiefly brownish gray, the praescutum with a broad central brown stripe, the lateral pair ill-defined. Pleura more brownish gray. Halteres whitened. Legs with the coxae brownish testaceous; trochanters yellow; remainder of legs brown. Wings (Fig. 24) narrow, subhyaline, the base more whitened; stigma pale brown, relatively inconspicuous; veins pale brown. Venation: R_{2+3+4} long, fully one-half the basal section of R_{2+3} ; supernumerary crossvein and vein R_5 relatively distant from one another, the space on R_{2+3} between them a trifle longer than the basal section of the same vein; R_{1+2} shorter than R_3 ; cell M_1 short.

Abdomen, including hypopygium, dark brown. Male hypopygium (Fig. 26) with the median region of the tergite, $9t$, only moderately rounded or convex, provided with coarse setae; lateral tergal arms long, incurved, the tips feebly dilated. Basistyle, b , at apex with two unequal lobes, the larger one with relatively few spinous setae on the apical third, the second lobe stouter and a little more than one-half as long, provided only with scattered setae. Interbase, i , large and conspicuous, appearing as a quadrate blade, the inner apical angle produced into a long, nearly straight spinous point. Dististyle, d , an oval ear-shaped blade, provided with scattered setae, some of those at tip larger and more conspicuous. Phallosome, p , with the central element or aedeagus expanded at apex into an oval head, the apophyses weakly dilated at tips.

Holotype, ♂, Big Meadow, North Santiam, August 17, 1947 (K. M. Fender).

This very small *Dicranota* is readily told from regional allies, including *Dicranota* (*Dicranota*) *astigma* sp. nov., and *D. (D.) argentea* Doane, by the small size and by

the structure of the male hypopygium, particularly the interbase. The similarity to *Dicranota* (*Plectromyia*) *cascadica* Alexander is discussed under the latter species.

Dicranota (*Polyangaues*) *maculata* (Doane, 1900).—Coast: Agate Beach, March 27, 1949 (F); Cascade Head Experimental Forest, May 23, 1948 (F); Castle Rock, March 31, May 13, 1949 (F); Gunaldo Falls, May 17, 1948, May 13, 1949 (F); Saddle Mt. (Boyer), September 20, 1933 (*Macnab*); Sand Lake, April 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, April 19, May 8, October 3-23, 1945, on sword fern; Sta. 3, April 17, May 1, 1946, April 24, May 14, 1947, May 11, 1948; Sta. 3A, April 17, May 6-21, October 11, 1946, May 5-19, 1947, April 27, May 17, 1948 (F). Archer's Camp, Creswell, April 26, 1942 (*Davis*); Forest Grove, May 20 (*Cole*); Happy Valley, McMinnville, April 14, May 12, 1946 (F); McMinnville, April 19, 1945 (F); Orchard View, May 4, 1949 (F); Silver Creek Falls, May 9, 1948 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946, July 17, 1947, July 31, 1948 (A & F). Salt Creek Falls, 3,800 ft., July 14, 1947 (A).

Dicranota (*Polyangaues*) *subapterogyne* Alexander, 1943.—Willamette Valley: Peavine, Sta. 2, April 26, 1947 (F), a single ♂. When compared with *maculata*, the relatively small dichoptic eyes of the male provide a character for ready identification.

Dicranota (*Rhaphidolabis*) *cayuga* (Alexander, 1916).—Coast: South fork of the Chetco River, March 18, 1940 (*Post & Ross*); Saddle Mt. (Boyer), April 27, 1935 (*Macnab*); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 3, April 26, May 16, 1946; May 20-30, 1947; Sta. 3A, May 19, 1947, June 2, 1948 (F). Silver Creek Falls, 1,000 ft., May 9, 1948 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946, July 17, 1947 (A & F); North Fork of Iron Creek, July 30, 1948 (A); Still Creek, July 16, 1947 (F); Tilly Jane Creek, July 18, 1947 (A & F). North Santiam, May 30, 1949 (F). Blue Mts.: Spring Creek, 3,900 ft., August 29, October 3, 1948, May 9, June 30, 1949 (*Baker*).

Dicranota (*Rhaphidolabis*) *cazieriana* Alexander, 1944.—Coast: Jordan Creek, September 5, 1948 (F). Willamette Valley: Peavine, Sta. 1, May 18, 1946; Sta. 3, July 2, 1948, September 11, 1948; Sta. 3A, May 23, June 30, 1947, June 8, September 10, 1948 (F).

Dicranota (*Rhaphidolabis*) *fenderi* sp. nov.—General coloration pale brown, the pleura more yellowed; antennal scape pale, flagellum brown; head brownish gray, paling to yellow behind; knobs of halteres infuscated; legs brownish yellow, the outer tarsal segments dark brown; wings whitish subhyaline, unpatterned; R_{2+3+4} present, unusually erect, subequal to $r-m$; R_s long, square and spurred at origin; male hypopygium with the tergite transverse, the caudal margin not produced, at midline with a semicircular notch that is bordered by a blackened area set with numerous small setae from conspicuous punctures; basistyle at apex broadly rounded, with erect spinous setae; interbase leg-shaped; dististyle unequally bifid, the outer arm a small cylinder that is tipped with about a dozen blackened points, the inner arm a long straight blade that narrows to the acute tip.

♂. Length, about 5.3-5.7 mm.; wing, 5.7-6.3 mm.

♀. Length, about 7 mm.; wing, 6 mm.

Rostrum light yellow; palpi dark brown. Antennae short, apparently 12-segmented; scape pale, remainder of organ brown; basal flagellar segments suboval, the subterminal ones lengthened; terminal segment very small; verticils much longer than the segments. Head brownish gray, the posterior portion obscure brownish yellow.

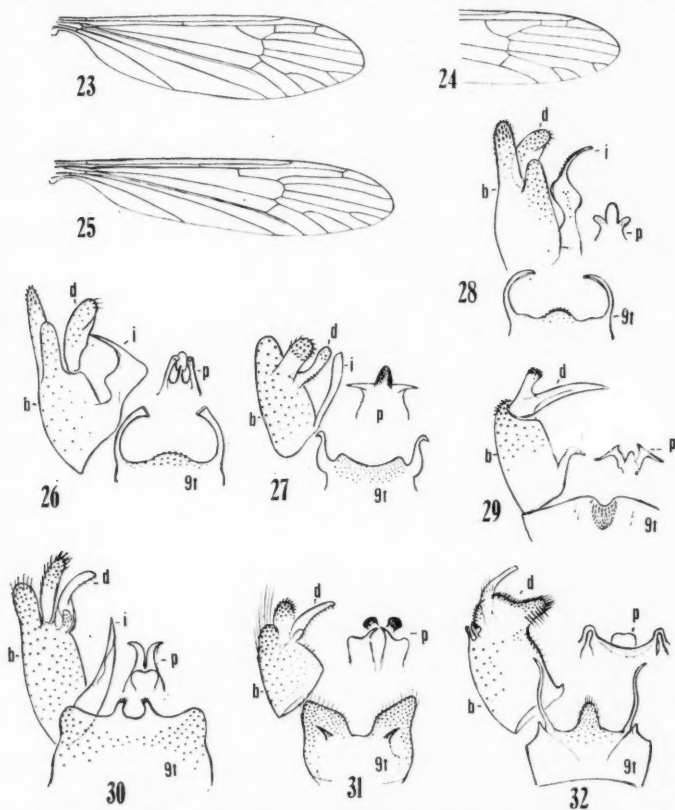
Thorax gibbous, the praescutum projecting strongly over the pronotum; dorsum pale brown or brownish buff, the posterior sclerites and pleura clearer yellow. Halteres pale, knob infuscated. Legs with the coxae and trochanters yellow; remainder of legs brownish yellow, the outer tarsal segments dark brown. Wings whitish subhyaline, unpatterned; veins pale brown. Venation: Sc_1 ending just beyond the level of the fork of R_s , Sc_2 , some distance before the origin of the latter; R_s unusually long, square and spurred at origin; R_{2+3+4} unusually erect, subequal to $r-m$, the latter shortly before the fork of R_s ; $m-cu$ about one-fifth its length beyond the fork of M .

Abdomen dark brown, sparsely pruinose; hypopygium somewhat more brightened. Male hypopygium (Fig. 29) with the tergite, $9t$, transverse, the caudal margin not produced as in other regional members of the genus, at the midline with a semicircular notch, behind which there is an oval blackened area set with small setae that arise from conspicuous punctures, the setae directed caudad. Basistyle, b , at apex broadly rounded, set with a number of erect to slightly retrorse spinous setae, interspersed with some unusually long setae. Interbase, i , leg-shaped, the foot portion flattened. Dististyle, d , unequally

bifid, consisting of two arms, the shorter cylindrical one tipped with about a dozen short blackened points, the inner arm a long straight blade that narrows gradually to the acute tip. Phallosome, *p*, small but relatively conspicuous, the gonapophyses exceeding the aedeagus in length, unequally bispinuous, the outer spine long and straight.

Holotype, ♂, Gunaldo Falls, Sourgrass Creek, Coast Range, May 17, 1948 (K. M. Fender). *Allotopotype*, ♀, with the type. *Paratopotype*, 1 ♂, pinned with the allotype; *paratypes*, 1 ♀, Saddle Mt. (Boyer), June 21, 1934 (Macnab); 1 ♂, Jessie M. Honeyman State Park, August 12, 1948 (K. M. Fender); ♂, Tierra del Mar, May 13, 1949 (K. M. Fender); 1 ♂, Silver Creek Falls, 1,000 ft., May 2, 1949 (K. M. Fender).

This entirely distinct fly is named for Kenneth M. Fender who is chiefly responsible for the success of the present Oregon list. Superficially it most resembles *Dicranota* (*Rhaphidolabis*) *xanthosoma* Alexander but the actual relationship to this species is



Figs. 23-25—Venation: 23. *Dicranota* (*Dicranota*) *astigma* sp. nov. 24. *D.* (*Dicranota*) *parvella* sp. nov. 25. *D.* (*Rhaphidolabis*) *uniplagia* sp. nov. 26-32. Male hypopygia: 26. *D.* (*Dicranota*) *parvella* sp. nov. 27. *D.* (*Dicranota*) *astigma* sp. nov. 28. *D.* (*Plectromyia*) *cascadica* Alexander. 29. *D.* (*Rhaphidolabis*) *fenderi* sp. nov. 30. *D.* (*Rhaphidolabis*) *polymeroides* Alexander. 31. *D.* (*Rhaphidolabis*) *uniplagia* sp. nov. 32. *D.* (*Rhaphidolabis*) *xanthosoma* Alexander (See fig. 1 for explanations of symbols).

remote, as can be seen by comparing the figures of the male hypopygia of the two species (Figs. 29 and 32).

Dicranota (Rhaphidolabis) integriloba Alexander, 1943.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 31, 1948 (F); Robin Hood Forest Camp, 3,560 ft., August 8, 1946 (A); Sahale Falls, 4,575 ft., July 17, 1947 (A & F); Tilly Jane Creek, 5,600 ft., July 30, 1948 (A). Wallawas: East Fork of Wallowa River, 5,450 ft., July 15, 1949 (Sperry); Lostine Valley, 5,000 ft., July 1, 1948 (A); Wallowa Creek, 4,675 ft., June 29, 1948 (A).

Dicranota (Rhaphidolabis) neomexicana (Alexander, 1912).—Coast: Gualdo Falls, June 6, 1949 (F).

Dicranota (Rhaphidolabis) nooksackensis Alexander, 1949.—Cascades: Mount Hood-Salmon River, July 30, 1948 (F). Tumalo Creek, Bend, 3,610 ft., August 14-15, 1948 (A).

Dicranota (Rhaphidolabis) polymoroides (Alexander, 1914).—Coast: Gualdo Falls, June 6, July 14, 1949 (F); Harris Beach State Park, August 11, 1948 (F); High Heaven, July 12, 1949 (F); Jordan Creek, September 5, 1948 (F); Saddle Mt. (Boyer), June 21, 1934, October 13, 1935 (*Macnab and associates*). Willamette Valley: Peavine, Sta. 1, May 23, 1947; Sta. 3, April 26, May 23, 1946, May 20, 1947, May 28, June 4, 1948; Sta. 3A, October 12, 1945, June 11, 1946, May 24, June 8, August 30, 1948 (F). Southern Oregon: State Line Creek, August 9, 1948 (A); Store Gulch Forest Camp, Illinois River, 970 ft., August 9, 1948 (A). Cascades: North Santiam, May 30, 1949 (F); Schweitzer Creek, near Westfir, 1,000 ft., August 5, 1946 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker); Pine Creek, 4,600 ft., June 25, 1948 (A).

Male hypopygium (Fig. 30) with the tergite, $9t$, very large, slightly narrowed outwardly; caudal margin with four lobes, the lateral pair short and stout, the intermediate lobes slender, tipped with a few strong setae; lateral emarginations shallow, the median one broadly U-shaped; lateral lobes with strong setae, the row continued across the mid-dorsal region. Basistyle, b , with two apical lobes, the outer one shorter and stouter, with long setae; inner lobe longer but more slender, especially at base, the setae somewhat stouter but elongate, especially at apex. Interbase, i , a large broad-based blade, gradually narrowed to the acute point, the outer portion more or less twisted. Dististyle, d , a little longer than the inner lobe of the basistyle, stout at base and here with a few small setae, the outer half more narrowed into a blade, its apex obtuse. Phallosome, p , with the apophyses projecting caudad beyond the level of the stout aedeagus, the apex of the latter weakly emarginate.

Dicranota (Rhaphidolabis) querula Alexander, 1944.—Blue Mts.: Spring Creek, 3,900 ft., August 29, 1948 (Baker). Wallawas: Lostine Valley, above French Forest Camp, 5,500 ft., August 19, 1948 (M. M. Alexander).

Dicranota (Rhaphidolabis) uniplagia sp. nov.—General coloration brownish gray, the praescutum with blackened stripes; antennae short, 14-segmented; wings brownish yellow, stigma and a spot over the cord brown; cell R_3 broadly sessile, cell M_2 open; male hypopygium with the caudal border of the large tergite broadly and deeply emarginate, without lateral arms but with a pair of acute spines on ventral surface; dististyle a slender rod that narrows to the obtuse tip.

♂. Length, about 8.5 mm.; wing, 10.5 mm.; antenna, about 1.2 mm.

Rostrum and palpi black. Antennae short, 14-segmented, black throughout; first flagellar segment nearly as long as the succeeding two combined; remaining segments oval, the terminal one about one-half longer than the penultimate. Head brown, the front light gray pruinose.

Pronotum black, gray pruinose. Thorax discolored, evidently brownish gray, the praescutum with black stripes, the median one broad. Pleura dull gray pruinose. Halteres with stem dirty white, the apex of knob more infuscated. Legs with the coxae gray pruinose; trochanters obscure yellow; remainder of legs black, the bases of the posterior femora restrictedly more yellowed. Wings (Fig. 25) brownish yellow, the prearcular and costal fields slightly darker; stigma large, brown; a conspicuous brown spot over the anterior cord, especially on $r-m$ and basal section of R_5 . Venation: R_1 relatively long, angulated and spurred at origin; R_{1+2} shorter than R_2 , the latter transverse; cell R_2 broadly sessile, R_{4+5} subequal in length to the basal section of R_5 and in oblique alignment with it; cell M_2 open, cell M_1 present; $m-cu$ more than one-fourth its length beyond the fork of M .

Abdomen dark brownish gray. Male hypopygium (Fig. 31) with the tergite, $9t$,

large, transverse, the caudal border broadly and deeply emarginate, the broad lateral lobes obliquely truncated, clothed with abundant long setae; no lateral tergal arms; on ventral surface near center of base of each lobe with an acute spine, directed laterad and slightly outward. Basistyle, *b*, with two apical lobes, the low outer one with long setae, the slightly larger oval inner lobe with numerous blackened spinous setae at apex; no developed interbase. Dististyle, *d*, a slender rod that narrows to the obtuse tip. Phallosome, *p*, consisting of flattened apophyses, the inner apical angle produced into a spine, the outer angle obtuse; aedeagus bifid.

Holotype, ♂, Sourgrass Creek, Coast Range, May 17, 1948 (K. M. Fender).

The only close ally of the present fly is *Dicranota* (*Rhaphidolabis*) *stigma* (Alexander), which differs in the venation and pattern of the wings, and in the structure of the male hypopygium, particularly the tergite and dististyle.

Dicranota (*Rhaphidolabis*) *xanthosoma* Alexander, 1944.—Coast: Saddle Mountain State Park, July 24, 1949 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (A); Hood Rapids, July 29, 1921 (*Melander*), type; Hood River Meadows, 4,500 ft., July 17, 1947 (A); Horsethief Meadows, 3,400 ft., July 18, 1947 (F); North Fork of Iron Creek, July 30, 1948 (F); Robin Hood Forest Camp, 3,560 ft., July 17, 1947 (A); Still Creek, 3,600 ft., July 16, 1947 (A); Stream below timberline, 5,000 ft., August 7, 1946, July 16, 1947 (A). Lost Prairie, 3,700 ft., August 3, 1948 (A); Odell Lake, Jungle Creek, 4,800 ft., July 13, 1947, August 6, 1948 (A & F); Salt Creek Falls, 3,800 ft., August 7, 1948 (A & F).

Male hypopygium (Fig. 32) with the tergite, *9t*, transverse; caudal margin generally truncate, the median area produced caudad into a large depressed lobe, obtuse, the surface densely covered with strong setae; on either side the tergite produced into a small sub-lateral point, and at nearly the same place or slightly more laterad with a long slender sinuous rod, its tip acute. Basistyle, *b*, simple, the only lobe being a small slender rod that is very inconspicuous. Interbase similarly very reduced, appearing as a small triangular blade at the extreme base of the mesal face of style. Dististyle, *d*, single, very large, occupying the whole apex of the basistyle, appearing as a slightly irregular lobe, the inner or rostral portion slightly more narrowed; outer lateral end further divided into a small, more sclerotized plate; apex of style at this point with numerous small blackened spicules, at summit the setae still spinous but longer, on the rostral portion passing into strong setae; on face of rostral area with about a dozen dark spinous setae of unusual length; on face of style with a long arm or blade that extends caudad beyond all other elements of the hypopygium, the apex broadly obtuse, the surface with five or six strong setae. Phallosome, *p*, broad, shaped about as figured.

Dicranota (*Plectromyia*) *cascadica* Alexander, 1949.—Cascades: Mount Hood-Bear Creek, 1,400 ft., August 7, 1946 (F). Described from Mount Rainier, Washington. The above specimen is evidently conspecific but shows slight differences in the structure of the male hypopygium that make it appear that the type, as originally described and figured, was somewhat deformed by mounting on a microscope slide. The hypopygium is therefore figured and re-described from the present material.

Ninth tergite (Fig. 28, *9t*) with the median region moderately produced, obtuse, provided with abundant setae; lateral tergal arms long and slender, blade-like, slightly more dilated before the subobtusate tip, before the latter on the lower margin with a low flange. Basistyle, *b*, with two apical lobes, the outer one more slender, on its apical fourth with peglike spinous setae that merge more basally into normal setae; shorter inner lobe stout, with elongate setae. Dististyle, *d*, very broad, its outer margin convex, the inner one more nearly straight, the tip obtuse, not emarginate, as indicated for the type. Interbase, *i*, large, broadly dilated just beyond midlength, thence narrowed into a long slender blade, the tip acute or subacute; outer margin with a row of delicate setae. Phallosome, *p*, with the apophyses small and weak, the aedeagus projecting a little beyond their ends.

The only other regional species of the subgenus having the median lobe of the ninth tergite low and obtuse is *Dicranota* (*Plectromyia*) *nooksackiae* Alexander, and races, differing in all details of structure of the hypopygium. In its general features, the hypopygium is more like that of *D. (Dicranota)* *parvella* sp. nov. (compare Fig. 26) which certainly appears to be correctly placed in the subgenus *Dicranota*. This resemblance of the hypopygia of two evidently distinct flies serves to confirm the belief in a very close relationship between the various so-called subgenera in *Dicranota*.

Dicranota (*Plectromyia*) *nooksackiae nooksackiae* Alexander, 1949.—Cascades: Big

Meadow, North Santiam, 3,460 ft., August 17, 1947 (F); Tumalo Creek, Bend, 3,610 ft., August 14-15, 1948 (A).

Dicranota (Plectromyia) nooksackiae subtruncifer subsp. nov.

♂. Length, about 4.5 mm.; wing, 5.5-5.2 mm.

♀. Length, about 5 mm.; wing, 5.5-5.7 mm.

Very similar to the typical form, differing in details of coloration, venation, and structure of the male hypopygium. It seems probable that more material will indicate that two distinct species are involved. Wings with the stigma pale brown, distinct, entirely lacking in the typical form. Venation, as compared with the typical form, with Sc short, ending opposite or just beyond the fork of R_{2+3+4} ; R_1 shorter and more strongly arcuated; cell R_3 long-petiolate by the presence of vein R_{2+3+4} , this element subequal to or longer than $r-m$. Male hypopygium with the median lobe of the tergite broad, its apex truncated; lateral tergal arms much as in the typical form. Interbase, apical lobe of basistyle and dististyle not greatly different from the typical form.

Holotype, ♂, Big Meadow, North Santiam, August 17, 1947 (K. M. Fender). *Allotopotype*, ♀. *Paratopotypes*, 7 ♂ ♀, with the types.

Dicranota (Plectromyia) reducta Alexander, 1921.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946, July 17, 1947, July 31, 1948 (A & F); North Fork of Iron Creek, 4,400 ft., July 31, 1948 (A); Robin Hood Camp, 3,560 ft., August 8, 1946 (A & F); Stream below timberline, 5,000 ft., July 16, 1947 (A). Odell Lake, 4,760 ft., August 4, 1946 (A); Salt Creek Falls, August 7, 1948 (A). Crater Lake-Annie Springs, 6,000 ft., August 1-3, 1946; Lost Creek, 5,900 ft., August 2, 1946 (A); Pole Creek Meadows, 5,900 ft., August 3, 1946, July 12, 1947 (A); August 7, 1948 (A & F).

HEXATOMINI

Paradelphomyia (Oxyrhiza) deprivata sp. nov.—Size relatively large (wing, male, about 6 mm.); mesonotum almost uniformly brownish yellow, unpatterned, pleura clearer yellow; wings faintly tinged with brown; macrotrichia of outer wing cells abundant; cell M_1 lacking; male hypopygium with the basistyle produced at apex into a sclerotized point that extends a short distance beyond the point of insertion of the dististyles; outer dististyle expanded at tip, with three conspicuous spines; gonapophysis a long flattened blade; ventral fork of aedeagus with the paired spines very long and slender, almost setoid.

♂. Length, about 5.5-5.5 mm.; wing, 5.8-6.3 mm.

♀. Length, about 5.5-5.7 mm.; wing, 5.5-5.7 mm.

Rostrum light brown; palpi dark brown. Antennae with scape light brown, the remainder of organ brownish black; outer flagellar segments elongate, with long verticils. Head dark brown.

Pronotum brown. Mesonotum almost uniformly brownish yellow, unpatterned; pleura and pleurotergite clearer yellow; setae of nota conspicuous. Halteres elongate, infuscated. Legs with the coxae and trochanters yellow; femora and tibiae obscure yellow, the tips narrowly brownish black; tarsi passing into black; tibial spurs distinct. Wings (Fig. 34) with a very faint brownish tinge, the prearcular and costal fields a little more yellowed; veins and trichia brown. Cells of wing tip with numerous trichia, including R_5 , through M_4 , in cells R_4 and R_5 , involving more than the outer half of the cell. Venation: Sc_1 ending just before the level of fork of R_1 , Sc_2 , some distance from its tip; R_{2+3+4} in direct alignment with R_{2+3} , the latter shorter than R_5 ; cell M_1 lacking; $m-cu$ more than one-half its length beyond the fork of M .

Abdomen dark brown, the basal sternites yellowed; hypopygium yellow. Male hypopygium (Fig. 33) with the basistyle, b , produced at apex into a sclerotized point that extends only a short distance beyond the point of insertion of the dististyles; outer surface of style with scattered coarse setae, more concentrated near the apex, on mesal face the setae much smaller and interspersed with small linear groups of setulae. Outer dististyle, d , slender, expanded at apex, with two outer spines and a stouter lower one. Inner dististyle broadest just beyond base, thence narrowed to the obtuse tip. Gonapophysis appearing as a long flattened blade, the base narrowed, much exceeding the aedeagus in length. Ventral fork of aedeagus, v , with the paired spines long and unusually slender, almost setoid.

Holotype, ♂, Beaver Creek, Mount Hood, 1,150 ft., August 7, 1946 (C. P. Alexan-

der). *Allotype*, ♀, Bear Springs Forest Camp, Mount Hood, August 8, 1941 (C. P. Alexander & K. M. Fender). *Paratypes*, ♂♂, with the allotype; numerous ♂♀, Prairie Creek, Humboldt Co., California, August 10-11, 1948 (C. P. Alexander & K. M. Fender); 1 ♂, Peavine Ridge, Station 3A, September 10, 1948 (K. M. Fender); ♂, Humbug Mountain State Park, August 11, 1948 (Fender); ♂, Silver Creek Falls, August 1-2, 1948 (Alexander & Fender).

The only other regional species of *Paradelphomyia* that has cell M_1 lacking is the eastern Nearctic *Paradelphomyia (Oxyrhiza) cayuga* (Alexander), a much darker species that has the details of structure of the male hypopygium entirely distinct.

Paradelphomyia (Oxyrhiza) pacifica Alexander, 1944.—Coast: Carlton-Meadow Lake Road, June 5, 1942 (Macnab), types; October 13, 1945 (F); Jordan Creek, September 5, 1948 (F); Pacific City, May 23, 1948 (F); Saddle Mt. (Boyer), May 9, 1935; Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 3, October 23, 1945, May 23, July 3, 1946, July 8, 1947, July 2, 1949; Sta. 3A, June 5, July 13, October 3-12, 1945, May 21, July 16, October 1-11, 1946, May 12-29, June 17, 1947, June 15, July 14, September 13, 1948, June 27, 1949 (F). Albrights, Dayton, September 19, 1946 (F); Silver Creek Falls, August 2, 1948, July 8, 1949 (F); Willamette River, near Dayton, June 4, 1948 (F). Cascades: Mount Hood-Beaver Creek, 1,150 ft., August 1, 1948 (A); Horsetail Falls, 100 ft., August 9, 1946 (A & F); below timberline, 5,000 ft., August 7, 1946 (A). Cascadia, 800 ft., August 2, 1948 (A & F); Salt Creek Falls, 3,800 ft., July 14, 1947, August 7, 1948 (A & F); Willis Creek, North Santiam, August 17, 1947 (Albright). Blue Mts.: Spring Creek, 3,900 ft., June 25, July 25, August 20-29, 1948 (Baker).

Austrolimnophila badia (Doane, 1900).—Coast: Castle Rock, March 31, 1949 (F); Deer Creek, McMinnville, May 6, 1945 (F); Glenada, May 23, 1947 (Malkin); High Heaven, June 22, 1945, May 4, 1947, July 12, 1949 (F); Pacific City, pupa in moss, May 23, 1948, emerged May 25 (F); Saddle Mt. (Boyer), June 21, 1934 (Macnab); Saddle Mountain State Park, July 24, 1949 (F); Sourgrass Creek, Gualdo Falls, May 17, 1948, June 6-30, 1949 (F); Three Rivers, May 23, 1948 (F); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 1, May 18, June 20, 1946, May 1-27, June 19, 1947; Sta. 2, May 26, 1947; Sta. 3, April 26, May 29, 1946, May 7-14, 1947, May 11, June 4, 1948, July 2, 1949; Sta. 3A, May 15-22, June 5-19, July 13, 1945, on sword fern; May 3, July 5, 1946, May 19-29, 1947, May 24, June 2-8, July 9-13, 1948 (F). Happy Valley, McMinnville, April 14, May 12, 1946 (F); Silver Creek Falls, June 25, 1939 (Aitken & Bohart), May 9, 1948, July 8, 1949 (F); Summit, 650-750 ft., June 8, 1929 (Scullen); Willamette River, south of Dayton, June 4, 1948, April 24, 1949 (F). Cascades: Mount Hood-Horsethief Meadows, 3,400 ft., July 18, 1947 (A & F); Still Creek, 3,600 ft., July 16, 1947; Metolius River, 2,400 ft., June 14, 1945, June 15, 1947 (F); North Santiam, May 30, 1949 (F). Eastern Oregon: Ochoco National Forest, June 14, 1947 (F). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A), May 8, June 5, 1949 (Baker).

Dactylolabis knowltoni Alexander, 1943.—Cascades: Crater Lake-along the Lake Trail at 6,300 ft., resting on cliff faces along the path, July 12, 1947 (A). Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F).

Dactylolabis nitidithorax (Alexander, 1918).—Coast: Coos Bay, May 23, 1947 (Malkin); Gualdo Falls, June 30, July 14, 1949 (F); High Heaven, June 7-22, 1945, May 4, 1947, July 12, 1949 (F); Saddle Mountain State Park, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 3, July 8, 1947 (F). Southern Oregon: South slope of Siskiyou Summit, June 8, 1947 (F). Cascades: Kelly Creek, June 22, 1947 (F); Salt Creek Falls, August 7, 1948 (F).

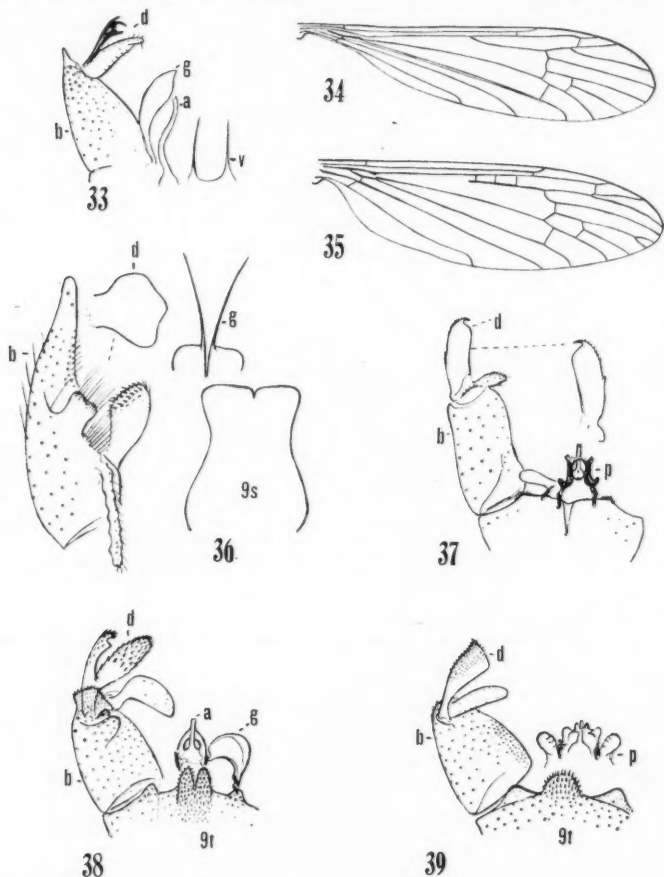
Dactylolabis postiana Alexander, 1944.—Willamette Valley: Vernonia, April 1, 1938 (K. Gray & J. Schuh); type. Southern Oregon: Oregon Caves, May 18, 1947 (Malkin). Cascades: McCredie Springs, April 26, 1947 (Malkin).

Dactylolabis pteropocila (Alexander, 1921).—Willamette Valley: Peavine, Sta. 1, May 5, 1945, on sword fern, April 30, May 2, 1946; Sta. 3, April 26, 1946, April 24, May 3-20, 1947, May 11-25, 1948; Sta. 4, May 2, 1947 (F). Corvallis, April 29, 1940 (Don Barber); Marys River, April 18, 1947 (R. F. Bruce); Silver Creek Falls, May 9, 1948 (F).

Phyllolabis fenderiana Alexander, 1949.—Cascades: Mount Hood-Sahale Falls, 4,575 ft., July 17, 1947, July 31, 1948 (A & F); part of type material.

Phyllolabis latifolia Alexander, 1920.—Willamette Valley; Peavine, Sta. 4, April 18, 1947 (F). Forest Grove, March 28, 1919 (Cole); type.

Male hypopygium (Fig. 36) complex in structure and describable in general terms only because of the condition of the material available. Appendage of the ninth sternite, *9s*, broad, widest across the base, thence slightly narrowed at midlength, beyond which it again widens slightly; apex nearly truncate, divided into two broad lobes by a narrow median split; entire surface provided with long delicate pale setae. Basistyle, *b*, produced far beyond the point of insertion of the dististyle into a flattened blade that narrows to the glabrous obtuse tip; surface of style at near the level of the dististyle with dense



Figs. 33-39.—33. *Paradelphomyia* (*Oxyrhiza*) *deprivata* sp. nov., male hypopygia. 34. *P.* (*Oxyrhiza*) *deprivata* sp. nov., venation. 35. *Limnophila* (*Elaeophila*) *aldrichi abrupta* Alexander, holotype, venation. 36-39. Male hypopygia: 36. *Phyllolabis latifolia* Alexander. 37. *Limnophila* (*Elaeophila*) *aldrichi abrupta* Alexander. 38. *L.* (*Elaeophila*) *bifida* Alexander. 39. *L.* (*Elaeophila*) *shannoni* Alexander (See fig. 1 for explanation of symbols).

brushes of setae, including a series of longer ones and an outer lobe that bears short more powerful bristles, the two sets obscuring the base of the dististyle which is shown separately in the figure; basad of the dististyle on the mesal face with a long pendulous cylindrical setiferous lobe that is directed cephalad. Dististyle, *d*, a broadly flattened pale blade, the stem short and stout, the surface glabrous or virtually so. Gonapophyses, *g*, unusually weak and slender, appearing as nearly straight rods, the tips abruptly pale and slightly constricted.

Limnophila (Elaeophila) aldrichi aldrichi Alexander, 1927.—Coast: Coquille River, Sitkum, August 4, 1948 (H. W. Thorne); High Heaven, July 12, 1949 (F). Willamette Valley: Silver Creek Falls, 1,000 ft., August 2, 1948 (A). Cascades: Dutchman's Flat, Century Drive, 6,100 ft., August 5, 1948 (A & F); Metolius River, August 3, 1948 (F). Crater Lake-Park Headquarters, 6,500 ft., August 2, 1946 (A); Pole Creek Meadows, 5,900 ft., August 7, 1948 (A & F). Wallows: Lostine Valley, 5,000 ft., August 18, 1948 (A).

Limnophila (Elaeophila) aldrichi abrupta Alexander, 1949.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946 (A); type. As stated in the original description (Alexander, 1949: 310), the venation of the holotype specimen was apparently abnormal (Fig. 35). The male hypopygium is shown (Fig. 37).

Limnophila (Elaeophila) aleator Alexander, 1945.—Blue Mts.: Mosquito Creek, Whitney, May 30, 1949 (Baker).

Limnophila (Elaeophila) angustior Alexander, 1919.—Willamette Valley: McMinnville, June 7, 1945 (F). Blue Mts.: Spring Creek, 3,900 ft., July 25, 1948 (Baker); Pendleton, along the Umatilla River, July 5, 1948 (A); Upper Walla Walla River, above Milton, 1,276 ft., July 4, 1948 (A); Whitney, June 19, 1949 (Baker).

Limnophila (Elaeophila) bifida Alexander, 1921.—Coast: Gunaldo Falls, May 13, 1949 (F); High Heaven, May 4, 1947 (F); Pacific City, May 23, 1948 (F); Tierra del Mar, May 13, 1949 (F). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker); Whitney, June 19, 1949 (Baker).

Male hypopygium (Fig. 38) with the caudal border of the tergite, *9t*, produced into two approximated submedian lobes that are densely spiculose; lower and poorly developed lobes lying more laterad. Basistyle, *b*, terminating in a subquadrate darkened lobe that is densely covered with short dark setae; mesal face of style near outer end with a rounded lobe that is provided with scattered coarse setae; a smaller darkened glabrous lobe near the base of the latter. Outer dististyle, *d*, deeply bifid, the outer arm more slender and a little shorter, its outer face and tip spiculose; inner arm large, the surface and margins with conspicuous appressed spines. Inner dististyle a flattened cleaverlike darkened blade. Gonapophyses, *g*, appearing as broadly flattened plates with rounded margins.

Limnophila (Elaeophila) shannoni Alexander, 1921.—Cascades: Mount Hood-Horseshoe Meadows, 3,400 ft., July 18, 1947 (A); Tilly Jane Creek, 5,600 ft., July 18, 1947 (A). Wallows: Eagle Cap Wilderness Area, 5,000 ft., June 28, 1948 (A).

Male hypopygium (Fig. 39) with the median lobe of the ninth tergite, *9t*, semioval, densely set with spinous setae, the subtriangular lateral lobes with short setulae. Dististyles, *d*, slightly subterminal in position, the outer a darkened club that is expanded outwardly, its apex truncated; outer surface and apex with microscopic appressed spinulae to produce a scabrous appearance. Inner dististyle nearly as long, narrowed outwardly.

Limnophila (Elaeophila) superlineata Doane, 1900.—Willamette Valley: Peavine, no station, May 5, 1945, on sword fern; Sta. 1, April 15, May 2, 1946, April 22, May 1, 1947 (F). Happy Valley, McMinnville, April 14, 1946 (F). Southern Oregon: Siskiyou Summit, June 10, 1945 (F).

Limnophila (Prionolabis) antennata Coquillett, 1905.—Cascades: Salt Creek Falls, 3,900 ft., August 7, 1948 (M. M. Alexander). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker); Pine Creek, 4,600 ft., June 25, 1948 (A).

Limnophila (Prionolabis) barberi Alexander, 1916.—Willamette Valley: Peavine, Sta. 1, May 23, 1947; Sta. 3, May 23, 1946; Sta. 3A, June 11, 1946 (F).

Male hypopygium (Fig. 40) with the lobes of the ninth tergite, *9t*, low and rounded; ninth sternite entire or with the border very gently concave. Outer dististyle, *d*, appearing as a slender rod, its tip blackened and provided with a few scattered setae; at base of style with a large oval fleshy setiferous lobe. Inner dististyle unequally bilobed, the outer lobe a straight blackened rod, the tip obtuse. Gonapophysis, *g*, a simple pale gently curved rod or very narrow blade. Aedeagus, *a*, dilated, varying somewhat in size in different specimens.

Limnophila (Prionolabis) boharti Alexander, 1943.—Cascades: Mount Hood-Tilly Jane Creek, 5,600 ft., July 18, 1947, July 29-30, 1948 (A); flying about the bases of

trees at dusk; wings of females reduced in size; Timberline Lodge, 5,500 ft., August 7, 1946 (*F* & *Macnab*); swept from clumps of bear-grass, *Xerophyllum*. Dutchman's Flat, Century Drive, 6,100 ft., August 5, 1948 (*F*); Mount McLoughlin, June 25, 1939 (*Aitken* & *Bohart*); types. Crater Lake-Lake Trail, on cliffs and banks, 6,100-6,600 ft., July 12, 1947 (*A*).

Male hypopygium (Fig. 41) with the lobes of the ninth tergite, *9t*, relatively narrow. Outer dististyle, *d*, unusually simple, the armature of outer half including a low darkened flange that is produced into one or two blunt teeth; appressed lobe on outer face at base elongate. Inner dististyle produced into a long slender fingerlike lobe that bears several erect setae. Gonapophysis, *g*, with the stem very slender, before tip much expanded, thence extended into a long straight point.

Limnophila (*Prionolabis*) *hepatica* Alexander, 1919.—Coast: Three Rivers, May 23, 1948 (*F*). Willamette Valley: Archer's Camp, Creswell, April 26, 1942 (*J. E. Davis*).

Male hypopygium (Fig. 42) somewhat as in *indistincta* but with all features accentuated and exaggerated. Ninth tergite, *9t*, with the lobes closely approximated. Basistyle, *b*, with a brush of long yellow setae on outer apical angle and with a dense brush or close comb of yellow setae on mesal face, with still other groups of setae near the outer part of the style. Outer dististyle more dilated before the shortened apex. Inner dististyle, *id*, unusually short and massive, the setal brush unusually abundant and dense; apex of style very obtuse. Gonapophysis, *g*, appearing as a slender yellow rod, a trifle more dilated at near midlength. A massive central structure, bilobed at apex and with the surface densely setuliferous, is represented in *indistincta* by a smaller and less developed organ (not shown in figure).

Limnophila (*Prionolabis*) *indistincta* Doane, 1900.—Coast: Gualdo Falls, July 14, 1949 (*F*); High Heaven, June 22, 1945, July 12, 1949 (*F*); Saddle Mt. (Boyer), November 18, 1933, June 21-28, 1934, July 21, August 15, 1935, August 7-16, 1937, July 19, 1938 (*Macnab* and associates); Saddle Mountain State Park, July 24, 1949 (*F*). Willamette Valley: Peavine, Sta. 1, July 12, 1946, May 22, 1947; Sta. 3, May 29, July 13, 1945, June 7, July 2, 1946, June 16, 1948, July 2, 1949; Sta. 3A, June 4, July 5, 1946, May 29, June 17, 1947, June 8, July 16, 1948 (*F*). Silver Creek Falls, July 8, 1949 (*F*). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (*F*); Beaver Creek, 1,150 ft., July 16, 1947 (*A* & *F*); Robin Hood Camp, August 8, 1946 (*A* & *F*); Still Creek, July 16, 1947 (*A* & *F*). Odell Lake, 4,760 ft., July 14, 1947, August 6, 1948 (*A*); Salt Creek Falls, 3,800 ft., July 14, 1947, August 7, 1948 (*A* & *F*).

Male hypopygium (Fig. 43) with the tergal lobes, *9t*, appearing as flattened hairy blades. Basistyle, *b*, with a modified setiferous lobule on mesal face. Outer dististyle a slender glabrous blade, the apex narrowed into a gently curved blackened rod. Inner dististyle, *id*, short and compact, on outer margin near base with a brush or pencil of unusually long yellow setae; a small group of long setae on ventral margin. Gonapophysis, *g*, appearing as an expanded yellow blade, the outer margin microscopically serrulate or crenulate.

Limnophila (*Prionolabis*) *oregonensis* Alexander, 1940.—Coast: Deer Creek, McMinnville, May 6, 1945 (*F*); Saddle Mt. (Boyer), April 21, May 6, 1934, May 19-26, 1935, May 24, June 16-24, 1936, June 7, 1937 (*Macnab* and associates); Tierra del Mar, June 30, 1949 (*F*). Willamette Valley: Peavine, Sta. 3, April 28, May 21, 1945, on sword fern; April 17, 1946; Sta. 3A and 4, April 17, 1946, April 19, 1947 (*F*). Cascades: North Santiam, May 30, 1949 (*F*).

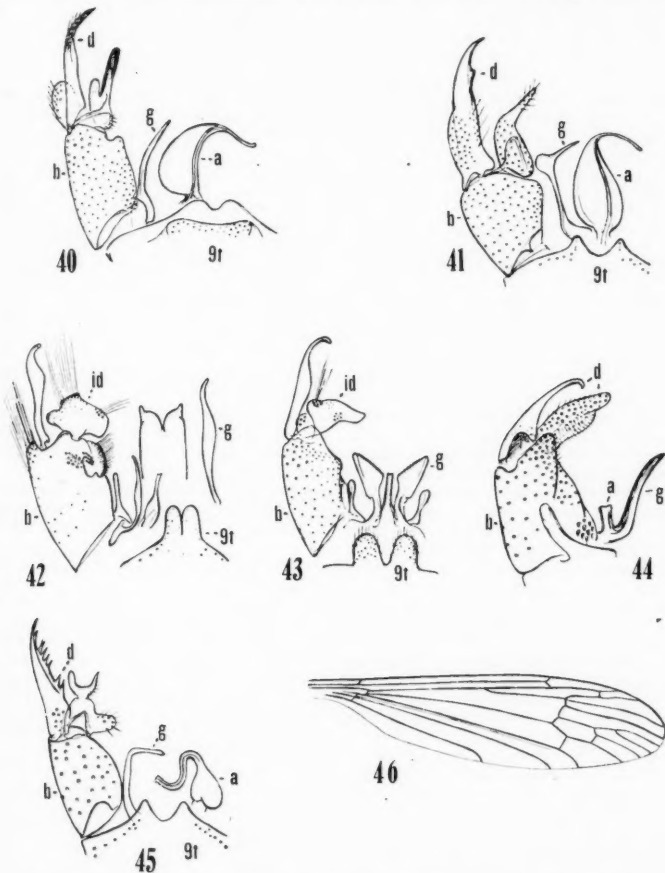
Male hypopygium (Fig. 45) with the tergal lobes, *9t*, relatively narrow, separated by a broad notch. Outer dististyle, *d*, conspicuously toothed on more than the distal half of the mesal edge, the number and size of the points slightly variable; lobe on outer face of style at base lacking. Inner dististyle with the outer part conspicuously bilobed, the outer lobe more slender and pointed, provided with long setae; pendant lobe of style conspicuous, obtuse. Gonapophysis, *g*, appearing as a long slender rod, before tip strongly bent, thence gradually narrowed to the blunt tip. Aedeagus, *a*, relatively small, as compared with other species of the subgenus.

Limnophila (*Prionolabis*) *scaria* Alexander, 1945.—Coast: High Heaven, June 7, 1945 (*F*); Tierra del Mar, June 30, 1949 (*F*). Willamette Valley: Peavine, Sta. 3, May 24, 1947 (*F*).

Limnophila (*Prionolabis*) *vancouverensis* Alexander, 1943.—Coast: Coos Bay, May 23, 1947 (*Malkin*); Glenada, May 23, 1947 (*Malkin*); Gualdo Falls, June 30, 1949 (*F*); Saddle Mt. (Boyer), May 27, June 21, 1934, June 19, July 14, 1935, May 24, July 5-13, 1936 (*Macnab* and associates), determined earlier as *cressoni*; part of type material. Willamette Valley: Peavine, Sta. 1, May 4-14, 1945, April 23-30, 1946; Sta.

3, April 22, May 16, 1946; Sta. 3A, May 29, 1947; Sta. 4, May 2, 1947 (F). Corvallis, April 29 (Cole auct.), determined by Alexander as *cressoni* in Cole List (1921); Dayton, Willamette River, April 24, 1949 (F); Low Pass Summit, April 13, 1947 (Malin); Silver Creek Falls, June 23, 1939 (Aiken & Bohart); part of type material. Cascades: Elk Lake, Marion Co., 3,850 ft., July 3, 1938 (M. C. Lane), part of type material; Prospect, May 22, 1921 (Dyar), part of type material; Salt Creek Falls, 3,800 ft., July 14, 1947 (A).

Limnophila (*Dendrolimnophila*) *albomanicata* (Alexander, 1945).—Coast: Gunaldo Falls, July 14, 1949 (F); High Heaven, July 12, 1949 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Wheeler, July 24, 1949 (F). Willamette Valley: Peavine,



Figs. 40-45.—Male hypopygia: 40. *Limnophila* (*Prionolabis*) *barberi* Alexander. 41. *L. (Prionolabis)* *boharti* Alexander. 42. *L. (Prionolabis)* *hepatica* Alexander. 43. *L. (Prionolabis)* *indistincta* Doane. 44. *L. (Phylidorea)* *rubida* Alexander. 45. *L. (Prionolabis)* *oregonensis* Alexander. 46. *Ulmomorpha* *aridela* Alexander, holotype, venation (See fig. 1 for explanation of symbols).

Sta. 3A, July 5, 1946, June 17, July 7, 1947, July 9, 1948 (F). Silver Creek Falls, 1,200 ft., August 2, 1948 (A & F). Cascades: Mount Hood-Beaver Creek, 1,150 ft., August 7, 1946, July 16, 1947, August 1, 1948 (A & F); Still Creek, 3,600 ft., July 16-17, 1947 (A & F). Salt Creek Falls, 3,800 ft., August 7, 1948 (F).

Limnophila (Phylidorea) claggi Alexander, 1930.—Coast: Gualdo Falls, June 30, 1949 (F); Pacific City, May 23, 1948 (F). Willamette Valley: Peavine, Sta. 1, May 23, 1947; Sta. 2, June 1-19, 1945, May 10, 1946, April 26, 1947; Sta. 3, May 16-29, 1946, May 7-30, 1947, June 4, 1948, June 6, 1949; Sta. 3A, May 21, June 11, 1946, May 19, 1947, June 2-30, 1948, May 24, 1949 (F). Happy Valley, McMinnville, April 14, 1946 (F); McMinnville, June 14, 1948 (F); Silver Creek Falls, July 8, 1949 (F). Southern Oregon: Ashland-Lake of the Woods, June 11, 1945 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946, July 17, 1947, July 31, 1948 (A & F); Horsethief Meadows, 3,400 ft., July 18, 1947 (F); Sahale Falls, 4,575 ft., July 17, 1947 (A & F). Odell Lake, 4,760 ft., July 13, 1947 (A). Crater Lake-Pole Creek Meadows, 5,900 ft., August 3, 1946 (A). Eastern Oregon: Ochoco National Forest, June 14, 1947 (F). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948, May 22, June 15, 1949 (A & Baker); Pine Creek, 4,900 ft., June 13, 1947, June 25, 1948 (Baker); Balloon Tree Trail, 5,000 ft., July 3, 1948 (A). Wallowas: Wallowa Lake, 4,410 ft., June 28, 1948 (A).

Limnophila (Phylidorea) euxesta Alexander, 1924.—Coast: High Heaven, May 4, 1947 (F); Pacific City, May 23, 1948 (F). Willamette Valley: Peavine, Sta. 1, May 22, July 13, 1945, May 24, June 20, 1946, May 15-23, 1947; Sta. 2, June 18, 1946, May 21-26, 1947; Sta. 3, May 29, June 26, 1946, May 14, 1947, June 25, 1948, July 2, 1949; Sta. 3A, May 21, July 5, 1946, May 5, June 17, 1947, May 12-24, June 30, July 14-16, 1948 (F). McMinnville, May 24, 1947 (F); Silver Creek Falls, August 1, 1948 (A & F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F); Hood River, June 30, 1917 (Melandar); Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F); Still Creek, 3,600 ft., July 16, 1947 (A & F). Kelly Creek, June 22, 1947 (F); Metolius River, 2,600 ft., July 15, 1947, August 3, 1948 (F); Prospect, May 23, 1921 (Dyar); type material.

Limnophila (Phylidorea) flavipila Doane, 1900 (as *flavipila*).—Willamette Valley: Panther Creek, McMinnville, July 14, 1948 (F).

Limnophila (Phylidorea) nycteris Alexander, 1943.—Southern Oregon: Ashland-Lake of the Woods, June 10, 1945 (F); Siskiyou Summit, June 10, 1945 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 31, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker).

Limnophila (Phylidorea) olympica Alexander, 1949.—Southern Oregon: Blue Creek, Siskiyou National Forest, August 9, 1948 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F). Elk Lake, Century Drive, 4,900 ft., August 5-6, 1948 (F).

Limnophila (Phylidorea) pacalis Alexander, 1949.—Blue Mts.: Langdon Lake, 4,990 ft., July 17, 1948 (Lane); August 17, 1948 (A); types.

Limnophila (Phylidorea) rubida Alexander, 1924.—Coast: High Heaven, August 6, 1946 (A & F). Willamette Valley: Peavine, Sta. 2, August 6, 1946; Sta. 3, June 14, July 2-16, August 13, 1946, July 8, 1947, July 2, 1949; Sta. 3A, July 12, 1945, August 12, 1946, July 24, August 30, September 13, 1948 (F). Silver Creek Falls, 1,200 ft., August 1, 1948 (A & F). Southern Oregon: State Line Creek, August 9, 1948 (A & F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (F); Beaver Creek, 1,150 ft., August 7, 1946 (A); Still Creek, 3,600 ft., July 31, 1948 (A & F). Marion Creek, August 17, 1947 (Albright); Prospect, May 23, 1921 (Dyar), type; Willis Creek, North Santiam, August 17, 1947 (Albright).

The male hypopygium is shown (Fig. 44).

Limnophila (Phylidorea) snoqualmiensis Alexander, 1945.—Coast: Charleston, June 23, 1948 (Macnab). Willamette Valley: Peavine, Sta. 1, May 31, June 5, 1945, May 2, June 10, 1946, May 22, June 24, 1947; Sta. 2, May 31, 1946 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946 (A & F). Clackamas Lake, 3,300 ft., August 8, 1946 (A & F). Blue Mts.: Spring Creek, 3,900 ft., June 24, 1948 (A).

Limnophila occidens Alexander, 1924.—Coast: High Heaven, July 12, 1949 (F); Wheeler, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 1, June 4, July 3, 1946, May 22, June 19, 1947; Sta. 3, May 16, July 16, 1946, May 24, July 1, 1947, June 16-29, July 14, 1948, July 2, 1949; Sta. 3A, June 11, July 13, September 17, 1945, June 19, July 13, September 24, 1946, June 30, July 7-24, 1947, June 8-24, July 9-16, 1948,

June 27, 1949 (F). Silver Creek Falls, 800 ft., August 2, 1948 (A & F); Willamette River, south of Dayton, June 4, 1948 (F); Zena, June 5, 1948 (F). Cascades: Mount Hood-Bear Creek, July 16, 1947, August 1, 1948 (A & F); Hood River Meadows, July 17, 1947, July 31, 1948; Horsethief Meadows, July 18, 1947 (F); Robin Hood Forest Camp, 3,560 ft., August 8, 1946, July 17, 1947 (A & F); Still Creek, July 16, 1947, July 31, 1948 (A & F); Tilly Jane Creek, 5,600 ft., July 29, 1948 (A & F). Dutchman's Flat, Century Drive, 6,100 ft., August 5, 1948 (F); Marion Creek, August 17, 1947 (Albright); Metolius River, 2,600 ft., June 15, 1947 (F). Crater Lake-Annie Springs, 6,000 ft., August 1-3, 1946 (A); Cold Springs, 5,900 ft., August 7, 1948 (A & F); Lost Creek, August 2, 1946 (A); Pole Creek Meadows, 5,900 ft., August 3, 1946 (A), July 12, 1947 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A); July 25, August 29, 1948, June 5, 1949 (Baker); Balloon Tree Trail, 5,000 ft., July 3, 1948 (A). Wallows: Aneroid Lake Trail, 7,000 ft., July 26, 1949 (Baker); Enterprise, 4,200 ft., June 29, 1948 (A); Lostine, July 2, 1948 (A); Wallowa Creek, 4,675 ft., June 29, 1948 (A).

Limnophila tetricola Alexander, 1945.—Cascades: Mount Hood-Sahale Falls, 4,575 ft., July 17, 1947, July 31, 1948 (A & F); in small swarms over stream below the falls, resting on boulders in stream bed; Stream below timberline, 5,000 ft., July 16, 1947 (A); Tilly Jane Creek, 5,600 ft., July 18, 1947, July 29, 1948 (A & F); flying in small swarms at sunset. Crater Lake-Above Annie Springs, 6,200 ft., August 2, 1946 (A); swept from low herbage along stream. Wallows: Aneroid Lake Trail, 7,000 ft., July 26, 1949 (Baker).

Pilaria imbecilla (Osten Sacken, 1859).—Coast: High Heaven, June 22, 1945 (F). Willamette Valley: Peavine, Sta. 1, May 29, July 3, 1946 (F).

Pilaria microcera Alexander, 1924.—Coast: Pacific City, May 23, 1948 (F). Willamette Valley: Peavine, Sta. 1, May 27, July 3, 1947, July 2, 1948; Sta. 3, June 20-21, July 16, 1946, May 14, 1947; Sta. 3A, October 3, 1946, May 29, 1947 (F). Cascades: Mount Hood—One mile south of the Wapinitia cutoff, August 7, 1946 (F); Still Creek, July 16, 1947, July 31, 1948 (A & F). Little Deschutes River, August 4, 1946 (A); Metolius River, 2,600 ft., August 3-14, 1948 (A & F); Prospect, May 23, 1921 (Dyar), type. Blue Mts.: Spring Creek, 3,900 ft., June 15, 1949 (Baker).

Ulolompha aridela Alexander, 1927.—Coast: Marshfield, June 27 (J. M. Aldrich); type. The wing is shown (Fig. 46).

The relationships existing between the various western species or forms in this genus are still not fully understood. The species are separated among themselves by the presence or absence of cell M_1 of the wings (cell M_1 preserved in *aridela* and *nigrodorsalis*, lacking in *sierricola* and *vanduzeei*) and in the presence or lack of blackened praescutal stripes.

Ulolompha nigrodorsalis Alexander, 1949.—Coast: Gualdo Falls, June 30, 1949 (F); Tillamook, September 19-21, 1949 (Davis). Willamette Valley: Peavine, Sta. 3, May 29, July 16, 1946, June 18, July 1, 1947, September 10, 1948, June 6, 1949; Sta. 3A, May 29, 1947 (F). Cascades: Mount Hood-Bear Springs, 3,200 ft., August 8, 1946 (A); Hazel Creek, near Dexter, 990 ft., August 5, 1946 (A).

Some of the specimens have the praescutal stripes paler than in others and thus approach the more southern *Ulolompha quinque-cellula* Alexander (as Peavine, Sta. 3, June 16, 1948).

Ulolompha sierricola Alexander, 1918.—Coast: High Heaven, August 6, 1946, July 12, 1949 (A & F). Willamette Valley: Peavine, Sta. 1, June 10, July 18, 1946, May 22-27, 1947; Sta. 3, May 29, June 13, 1946, July 8-12, 1947, June 25, 1948, July 2, 1949; Sta. 3A, June 15, 1948 (F). Willamette River, June 4, 1948 (F). Cascades: Mount Hood-Bear Creek, August 1, 1948 (A & F); Hood River Meadows, July 17, 1947 (A & F); Horsethief Meadows, August 9, 1946, July 18, 1947 (A & F); Multnomah Falls, August 9, 1946 (F); Onconota Gorge, July 19, 1947 (A); Still Creek, 3,600 ft., July 16-17, 1947 (A & F); below timberline, 5,000 ft., August 7, 1946 (A & F). Metolius River, 2,600 ft., August 3, 1948 (A & F); Odell Lake, August 4, 1946 (A); Schweitzer Creek, Willamette River, 1,000 ft., August 5, 1946 (A); Tombstone Meadows, South Santiam, August 17, 1947 (Albright). Blue Mts.: Spring Creek, 3,900 ft., June 25, July 25, 1948 (Baker); South Fork of the Upper Walla Walla River, 1,450 ft., July 4, 1948 (A).

Ulolompha vanduzeei Alexander, 1920.—Willamette Valley: Silver Creek Falls, August 2, 1948 (A). Southern Oregon: State Line Creek, 1,700 ft., August 7, 1948

(A & F). Cascades: Odell Lake, Jungle Creek, 4,800 ft., August 6, 1948 (F); Salt Creek Falls, 3,800 ft., August 7, 1948 (A).

Hexatoma (Eriocera) austera (Doane, 1900) (*obscura* Williston, 1893).—Coast: Castle Rock, May 13, 1949 (F). Willamette Valley: Willamette River, near Dayton, on gravel bar, April 17, 1948 (*Dorothy McKey-Fender*); associated with *Protanoderus vipio*. Wallows: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (A); Five miles east of Minam, Wallowa Canyon Fount, 2,700 ft., July 21, 1929 (*Scullen*).

Hexatoma (Eriocera) eriophora (Williston, 1893).—Eastern Oregon: Grant Co., July 1, 1914 (*W. J. Chamberlin*). Blue Mts.: Anthony Lake, 7,100-8,650 ft., August 4, 1929 (*Scullen*); Upper Walla Walla River, August 17, 1948 (A).

Hexatoma (Eriocera) sculleni Alexander, 1943.—Coast: High Heaven, August 6, 1946 (A); a single wing caught in a spider's web close to stream. Cascades: Cascadia, 800 ft., August 15, 1924 (*Scullen*), type; North Santiam, near summit of highway, August 17, 1947 (*Kenneth Albright*).

Hexatoma (Eriocera) solor Alexander, 1943.—Coast: Mount Alsea, August 8, 1932 (*James Roaf*), type; Oregon State Agricultural College.

Hexatoma (Eriocera) velveta (Doane, 1900).—Willamette Valley: Corvallis, May 28 (*A. L. Lovett*); Happy Valley, McMinnville, May 12, 1946 (F); Summit, 650 ft., June 23, 1929 (*Scullen*).

ERIOPTERINI

Crypteria americana Alexander, 1917.—Coast: Carlton-Meadow Lake Road, October 13, 1945 (F); Saddle Mt. (Boyer), September 29, October 29, 1934, October 30, 1937 (*Macnab and associates*). Willamette Valley: Peavine, Sta. 1, September 18, October 12, 1945; Sta. 3, November 8, 1945, October 16, 1946; Sta. 3A, October 1-18, 1946 (F). Mount Angel, 165 ft. (F. Epper); type.

Cladura (Cladura) macnabi Alexander, 1944.—Willamette Valley: McMinnville, October 3, 1936 (*Macnab*); type.

Cladura (Cladura) nigricauda sp. nov.—General coloration of thorax reddish brown, variegated with darker; antennae 12-segmented, the fusion-segment elongate, with nine free segments beyond it; wings whitish subhyaline, with weak darkened seams along veins Cu and 2nd A; Rs strongly arcuated at origin; R_{2+3+4} about one-half longer than R_{2+3} ; outer abdominal segments, including the hypopygium, black; male hypopygium with the tergal lobes almost glabrous; gonapophysis very large, unequally bispinous, the axial spine largest.

♂. Length, about 6.65 mm.; wing, 7.75 mm.; antenna, about 1.3-1.4.

Rostrum brown, pruinose; palpi dark brown. Antennae (Fig. 48) dark brown, the scape weakly pruinose; 12-segmented, there being nine segments beyond the fusion, the latter evidently composed of five segments, of which the last is indicated by an incomplete suture, the others only by the setal arrangement. Head dark gray.

Pronotum pale brown, more yellowed on the margins, the surface sparsely pruinose. Mesonotum reddish brown, the praescutum with a conspicuous darker brown median stripe; scutal lobes with darkened centers; scutellum restrictedly darkened medially; medio-tergite dark brown, the margins and the pleurotergite yellow. Pleura yellow, restrictedly darkened on the anepisternum and again on the ventral sternopleurite. Halteres uniformly pale yellow. Legs with the coxae and trochanters yellow; remainder of legs yellow, the tips of both femora and tibiae restrictedly more darkened, tarsi passing into black; legs relatively long and slender, only moderately hairy; no tibial spurs; claws long and slender. Wings (Fig. 47) whitish subhyaline, the prearcular field and vein Sc more whitened; weak darkened seams along veins Cu and 2nd A; veins brown, paler at and near the wing base. Venation: Rs strongly arcuated at origin; R_{2+3+4} about one-half longer than R_{2+3} ; cell M_1 varying from a trifle longer than its petiole to about twice this length; $m-cu$ oblique, about one-fourth its length beyond the fork of M .

Abdomen dark brownish gray, the hypopygium almost uniformly black. Male hypopygium (Fig. 49) with the tergite, 9t, having the lobes small, separated by a low V-shaped notch, almost glabrous. Basistyle, b, slender, without the conspicuous apical lobe found in *bradleyi* and *macnabi*. Dististyle, d, arcuate, gradually narrowed to the obtuse tip which is set with abundant blackened spinulae; concave or mesal face of style with conspicuous long erect setae, these small and little evident on the outer face. Gonapophy-

sis, g, very conspicuous, unequally bifid, the axial spine largest, incurved, the small lateral spine about one-third as large.

Holotype, ♂, Peavine Ridge, Station 3A, October 12, 1946 (K. M. Fender). *Paratopotypes*, ♂♂, October 1, 18, 21, 1946 (Fender).

The most similar species are *Cladura* (*Cladura*) *macnabi* Alexander and *C. (Pterochionea) bradleyi* (Alexander), which differ very conspicuously in the structure of the male hypopygium and likewise in the antennae. These two species further differ among themselves in various details of structure of the male hypopygia, as follows: *C. (C.) macnabi*.—Tergal lobes scarcely evident; gonapophysis very small and simple, broadest at base, narrowed and becoming paler at outer end, finally produced into a long slender spine; apex of dististyle with a group of very small short spinous points. *C. (P.) bradleyi*.—Tergite with a concentration of long black setae on the lobes, forming distinct tufts or brushes; gonapophysis appearing as a broad flattened plate, the outer margin with microscopic denticles, of which two are larger; at base of phallosome with two further strong slender spines.

It is becoming increasingly difficult to separate the two supposed subgenera *Cladura* Osten Sacken and *Pterochionea* Alexander, and it will probably be found necessary to abandon the latter group.

Cladura (*Cladura*) *oregona* Alexander, 1919.—Coast: Lee's Camp, September 18-25, 1949 (Davis); Saddle Mt. (Boyer), October 14, 1933, September 22, 1935, September 10, 1936 (*Macnab* and *associates*). Willamette Valley: Peavine, Sta. 3, October 3-12, November 8, 1945; Sta. 3A, October 1-12, 1946 (F). Forest Grove, September 30 (Cole); type. Cascades: Mount Hood-Clear Lake, 3,300 ft., October 7, 1945 (F).

Cladura (*Pterochionea*) *bradleyi* (Alexander, 1916).—Cascades: Still Creek, 3,600 ft., October 6, 1945 (F).

Chionea macnabeana Alexander, 1946.—Coast: Wilson River, Tillamook Burn, 2,125 ft., February 8, 1946 (*Mucnab*); type.

Lipothrix fenderi Alexander, 1945.—Coast: Chetco River, August 11, 1948 (F); Jessie M. Honeyman State Park, August 12, 1948 (F); Lee's Camp, September 18-25, 1949 (Davis). Willamette Valley: Peavine, Sta. 3, September 18-23, 1945; Sta. 3A, September 18-October 12, 1945; October 1-12, 1946, September 10-13, 1948 (F); types. Albrights, Dayton, September 19, 1946 (F). Cascades: Tombstone Meadows, South Santiam, August 17, 1947 (F).

Lipothrix nigrilinea (Doane, 1900).—Coast: Gunaldo Falls, June 6, July 14, 1949 (F); High Heaven, July 12, 1949 (F). Willamette Valley: Peavine, Sta. 1, June 17, July 3, August 6, 1946 (F). Silver Creek Falls, Lower South Falls, 800 ft., August 2, 1948 (A & F).

Gonomyia (Idiocera) brookmani Alexander, 1944.—Blue Mts.: Little Phillips Creek, above Elgin, 2,850 ft., July 2, 1948 (A).

Male hypopygium (Fig. 50) with the apex of the lobe of the basistyle, *b*, extended into a pale acute point. Three dististyles, *d*, or arms, the two heavily blackened ones broadly united basally, the outer style or arm stouter, its apex truncate; inner arm more slender, bispinuous at apex; inner dististyle a broadly expanded pale triangular blade, provided with long conspicuous setae. Aedeagus, *a*, elongate, pale, the apex a recurved slender point. In the present specimen, the acute pale tip of the lobe of the basistyle is not clearly visible.

Gonomyia (Idiocera) coloradica Alexander, 1920.—Cascades: Tumalo Creek, near Bend, 3,610 ft., August 15, 1948 (A).

Gonomyia (Idiocera) gothicana Alexander, 1943.—Cascades: Trout Creek Forest Camp, South Santiam, 1,245 ft., August 2, 1948 (A).

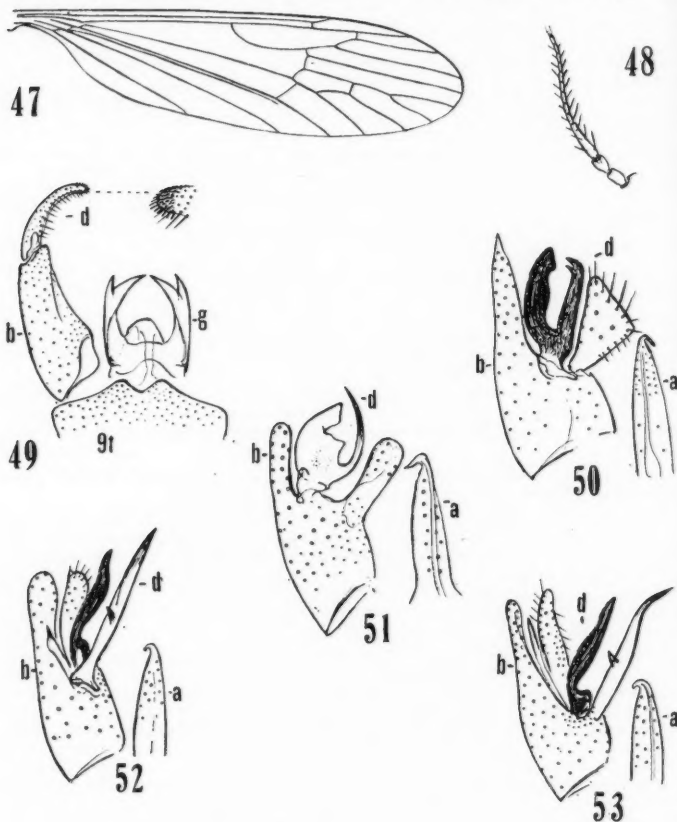
Gonomyia (Idiocera) lindseyi Alexander, 1944.—Blue Mts.: Mosquito Creek, Whitney, June 19, 1949 (Baker). Known hitherto only from the unique type, Modoc Co., California, 5,000 ft., July 1922.

There are slight differences in the male hypopygia of the two known specimens and these are shown in the accompanying drawings. In the type (Fig. 52), the apex of the lobe of the basistyle, *b*, is broadly obtuse. Four dististyles, *d*, or major branches of the same, the longest a relatively narrow straight blade, the tip acute, at near midlength bearing a strong black spine; next longest or second style a simple blackened rod that is strongly constricted or sinuous at near one-third the length, the tip subacute; third style a broadly flattened pale blade, subequal in size and shape to the lobe of the basistyle, provided with pale setae; fourth style a slender pale rod, the acute tip pointed and

blackened. Aedeagus, *a*, slender, entirely pale, the apex a short curved hook. The second or Oregon specimen (Fig. 53) has the outer lobe of the basistyle, *b*, narrow; third dististyle, *d*, narrower; apex of fourth style more extended, and the lateral spine of the second style stouter. Because of this insufficient material, it cannot be stated as to whether the above represents normal variation within a single species or whether distinct races are involved.

Gonomyia (Idiocera) shannoni Alexander, 1926.—Willamette Valley: Peavine, Sta. 3A, June 7, July 2, 1946, June 24, 1948, July 12, 1949 (*F*). Cascades: Crater Lake-Pole Creek Meadows, 5,900 ft., August 3, 1946, July 12, 1947 (*A*); August 7, 1948 (*A* & *F*).

Male hypopygium (Fig. 51) with the outer lobe of basistyle, *b*, a fleshy pale lobe, the tip broadly obtuse. Two dististyles, *d*, the outer one a large complex blackened structure shaped about as figured, including a broadly flattened outer arm with the apex trun-



Figs. 47-53.—47. *Cladura (Cladura) nigricauda* sp. nov., venation. 48. *C. (Cladura) nigricauda* sp. nov., antenna. 49-53. Male hypopygia: 49. *Cladura (Cladura) nigricauda* sp. nov. 50. *Gonomyia (Idiocera) brookmani* Alexander, holotype. 51. *G. (Idiocera) shannoni* Alexander. 52. *G. (Idiocera) lindseyi* Alexander, holotype. 53. *G. (Idiocera) lindseyi* Alexander (See fig. 1 for explanation of symbols).

cated, and a basal elongate slender spine, the margin between these two points further produced into a triangular point; disk of style broadly expanded, provided with microscopic setae. Inner dististyle generally similar in shape and appearance to the lobe of the basistyle, appearing as a flattened pale blade, its apex obtuse. Aedeagus, *a*, narrowed outwardly, the apex a spinous point.

Gonomyia (Gonomyia) aciculifera Alexander, 1919.—Willamette Valley: Peavine, without station number, May 21, 1945 (F). Southern Oregon: Store Guich Forest Camp, swept from willows along the Illinois River, August 9, 1948 (A & F). Cascades: Westfir, 1,000 ft., August 5, 1946 (A).

Gonomyia (Gonomyia) bihamata Alexander, 1943.—Willamette Valley: Peavine, Sta. 1, June 24, 1947; Sta. 3, July 16, 1946; Sta. 3A, May 23, 1947 (F). Cascades: Mount Hood-Tilly Jane Creek, 5,600 ft., July 18, 1947 (A). Dutchman's Flat, 6,100 ft., August 5, 1948 (A & F). Crater Lake-Annie Springs, 6,000 ft., August 1, 1948 (A); Castlecrest Garden, 6,800 ft., July 12, 1947 (A); Pole Creek Meadows, 5,900 ft., July 11, 1947, August 7, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A & Baker); Anthony Lake, 7,100 ft., August 7, 1929 (Scullen); Lime, Burnt River, 2,400 ft., June 24, 1948 (A); Whitney, June 19, 1949 (Baker). Wallows: Wallowa Creek, at spring, 4,675 ft., June 29, 1948 (A).

Gonomyia (Gonomyia) flavibasis Alexander, 1916 (*tuberculata* Alexander, 1925).—Willamette Valley: Peavine, Sta. 3, May 14, 1947; Sta. 3A, August 6, 1946, June 15, July 24, 1948 (F); McMinnville, July 14, 1944 (F); Orchard View, McMinnville, May 4, 1949 (F); Panther Creek, McMinnville, July 14, 1948 (F). Blue Mts.: Spring Creek, 3,900 ft., June 15, 1949 (Baker); Upper Walla Walla River, 1,450 ft., August 17, 1948 (A).

Gonomyia (Gonomyia) percomplexa Alexander, 1945.—Coast: Coquille River, Sitkum, August 5, 1948 (H. W. Thorne). Willamette Valley: Peavine, June 6, 1945 (F), type; Sta. 1, June 10, July 3, 1946, June 19, July 3, 1947; Sta. 3, June 17, July 16, 1946; Sta. 3A, May 21, July 5, 1946 (F). McMinnville, Panther Creek, July 14, 1948 (F); Silver Creek Falls, July 8, 1949 (F); Willamette River, 5 miles south of Dayton, June 4, 1948 (F). Cascades: Mount Hood-Polly Forest Camp, 3,000 ft., August 9, 1946 (A); Salt Creek Falls, 3,800 ft., August 7, 1948 (A).

Gonomyia (Gonomyia) poliocephala Alexander, 1924.—Willamette Valley: Peavine, no station, June 1, 1945 (F). McMinnville, May 9, 1945 (F). Cascades: Trout Creek Forest Camp, South Santiam, 1,245 ft., August 2, 1948 (A). Blue Mts.: Upper Walla Walla River, 1,450 ft., July 4, 1948 (A). Wallows: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (A).

Gonomyia (Gonomyia) virgata Doane, 1900.—Coast: Eel Creek Forest Camp, August 11, 1948 (F); Gualdo Falls, June 6, 1949 (F); Pacific City, May 23, 1948 (F); Wheeler, July 24, 1949 (F). Willamette Valley: Peavine, Sta. 1, June 20, 1946; Sta. 3, June 13, July 2, 1947, June 4, 1948; Sta. 3A, October 1, 1946, May 29, 1947 (F).

Rhabdomastix (Sacandaga) fasciger Alexander, 1920 (*subfasciger* Alexander, 1927).—Coast: Chetco River, August 11, 1948 (F); Coquille River, Sitkum, August 2, 1948 (H. W. Thorne); High Heaven, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Saddle Mountain State Park, July 24, 1949 (F). Willamette Valley: Peavine, no station, May 16, 1945 (F). Cascades: Mount Hood-Beaver Creek, 1,150 ft., July 16, 1947 (A); Multnomah Falls, 100 ft., August 9, 1946 (F). Cultus Lake, 4,670 ft., August 6, 1948 (A); Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Blue Mts.: Upper Walla Walla River, above Milton, 1,275 ft., July 4, 1948 (A).

Rhabdomastix (Sacandaga) leonardi Alexander, 1930.—Blue Mts.: Little Phillips Creek, 2,850 ft., July 3, 1948 (A); Pendleton, along Umatilla River, 1,070 ft., July 5, 1948 (A). Wallows: Hurricane Creek, 5,460 ft., July 11, 1949 (Sperry); Johnson Park, Wallowa River, 2,750 ft., August 18, 1948 (A).

Rhabdomastix (Sacandaga) setigera Alexander, 1943.—Coast: Jordan Creek, Wilson River, September 5, 1948 (F); Lee's Camp, September 18-25, 1949 (Davis). Generally similar to the type (Gothic, Colorado) but even larger and with the details of venation slightly different. The male hypopygia are very similar in both lots of specimens. Attention is called to the prominent setigerous tubercles on the caudal margin of the inner dististyle.

Rhabdomastix (Sacandaga) trichophora Alexander, 1943.—Cascades: Cascadia, 800 ft., August 2, 1948 (F); Dutchman's Flat, August 5, 1948 (A); Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Crater Lake-Annie Springs, 6,000 ft., August 1, 1946 (A).

Cryptolabis (Cryptolabis) bisnuata Doane, 1900 (*pachyphallus* Alexander, 1943).—

Coast: Humbug Mountain State Park, August 11, 1948 (F). Eastern Oregon: Ochoco Forest Camp, Ochoco Mts., 4,000 ft., August 15, 1948 (A). Wallows: Johnson Park, Wallowa River, 2,750 ft., August 20, 1948 (A).

Cryptolabis (Cryptolabis) retrorsa Alexander, 1950.—Southern Oregon: Store Gulch Forest Camp, Siskiyou National Forest, 950 ft., August 9, 1948 (A & F); in great numbers along margins of Illinois River, swept from willow, alder and ash; type material.

Erioptera (Gonempeda) burra Alexander, 1924.—Coast: Castle Rock, May 13, 1949 (F); Tierra del Mar, May 13, 1949 (F). Willamette Valley: Peavine, Sta. 1, May 8, June 1, 1945, April 23, May 2, 1946, May 10, 1949; Sta. 3A, May 3, 1946 (F). Muddy Valley, McMinnville, May 9, 1945 (F). Southern Oregon: Ashland-Lake of the Woods, June 10, 1945 (F). Eastern Oregon: Malheur National Forest, Seneca, June 12, 1947 (F); Ochoco National Forest, June 14, 1947 (F). Blue Mts.: Whitney, June 19, 1949 (Baker). Wallows: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (A).

Erioptera (Empeda) alicia Alexander, 1914.—Willamette Valley: Peavine, Sta. 3A, May 16, 1945, May 12-15, 1946 (F). Forest Grove, June 3, (Cole); Grand Island, Willamette River, June 5, 1949 (F); Happy Valley, McMinnville, May 12, 1946 (F); Henderson Bridge, June 16, 1948, May 22, 1949 (F); Panther Creek, McMinnville, May 23, 1949 (F).

Male hypopygium (Fig. 54) with the outer dististyle, *d*, much as in other species of the subgenus, unequally bilobed at tip, the outer arm elongate, the shorter inner one darkened at apex and produced laterad into a small acute spine. Inner dististyle of unique conformation, very broad-based, the outer apical angle produced into a very powerful, strongly sinuous arm that gradually narrows into the acutely pointed blackened tip.

Erioptera (Mesocyphona) distincta Alexander, 1912.—Blue Mts.: Mosquito Creek, Whitney, June 19, 1949 (Baker); Spring Creek, 3,900 ft., June 15, 1949 (Baker).

Erioptera (Mesocyphona) dulcis Osten Sacken, 1877.—Willamette Valley: Peavine: Sta. 1, July 12, 1946; Sta. 3, July 2-16, September 13, 1946, June 12, July 8, 1947, June 29, 1948, July 2, 1949; Sta. 3A, July 11, September 18, October 17, 1945, July 5, August 6, 1946, May 29, June 17, 1947, July 9-16, August 30, September 13, 1948, June 27, 1949 (F). Silver Creek Falls, August 2, 1948 (A & F). Southern Oregon: O'Brien, 1,475 ft., August 9, 1948 (A & F). Cascades: Mount Hood-Below timberline, 5,000 ft., August 7, 1946 (A); Still Creek, 3,600 ft., July 16, 1947 (A & F); Summit Meadow, June 29, 1947 (F). Metolius River, 2,600 ft., August 3, 1948 (A & F). Blue Mts.: Spring Creek, 3,900 ft., June 24-27, July 25, 1948, June 15, 1949 (Baker); Pine Creek, June 30, 1949 (Baker & Sperry). Wallows: Enterprise, 4,200 ft., June 29, 1948 (A).

Erioptera (Mesocyphona) melanderiana Alexander, 1944.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947, July 31, 1948 (A & F). Odell Lake, Lazy Creek, 4,800 ft., August 4, 1946 (A). Crater Lake-Castlecrest Garden, 6,800 ft., August 2, 1946 (A); Pole Creek Meadows, 5,900 ft., August 3, 1946, July 12, 1947 (A), August 7, 1948 (A & F).

Erioptera (Erioptera) dyari Alexander, 1924.—Willamette Valley: Peavine, Sta. 3, September 27, October 23, 1945, May 23, July 21, September 13, 1946 (F). Cascades: Metolius River, River Island Forest Camp, August 4, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., August 10, 1949 (Baker).

Erioptera (Erioptera) oregonensis Alexander, 1920.—Coast: Grand Ronde, March 31, 1949 (F); High Heaven, Edmunds Ranch, April 1, 1949 (F); Saddle Mt. (Boyer), April 11, May 2, 1937 (Macnab); Sand Lake, April 12, 1949 (F); Tillamook, March 26, 1919 (A. C. Burrill), type; Wallace Bridge, March 31, 1948 (F). Willamette Valley: Peavine, Sta. 3, February 12, 1946, April 13, 1949 (F). Happy Valley, McMinnville, April 14, 1946 (F).

Male hypopygium (Fig. 55) with the dististyles, *d*, nearly terminal, the outer style large, blackened, on outer face at near midlength with a low lobe, the apex broadly flattened and provided with parallel rows of spinous setae. Inner dististyle a simple rod, about the apical third expanded, with a strong seta at apex; surface nearly glabrous, the face of the expanded portion with microscopic setulae. Gonapophysis, *g*, on slides each appearing as a triangular blackened blade, the tip acute, the blades divergent. Aedeagus small.

Erioptera (Erioptera) septemtrionis Osten Sacken, 1859 (*subseptemtrionis* Alexander, 1920.—Willamette Valley: Peavine, no station, April 19, May 4, 1945 (F). Happy

Valley, McMinnville, April 14, 1946 (F); Silver Creek Falls, May 9, 1948 (F). Southern Oregon: O'Brien, 1,475 ft., August 9, 1948 (A & F). Blue Mts.: Spring Creek, 3,900 ft., July 15, 1948, May 9, 1949 (Baker); Little Phillips Creek, 2,850 ft., July 2, 1948 (A); South Fork of Upper Walla Walla River, 1,450 ft., July 4, 1948 (A). Wallawas: Enterprise, 4,200 ft., June 29, 1948 (A); Lazy T Ranch, July 11, August 28, 1949 (Sperry).

Erioptera (Symplecta) cana (Walker, 1848) (All American records for *hybrida* Meigen, 1804, and *punctipennis* Meigen, 1818).—Willamette Valley: Peavine, June 18, 1948; Sta. 3, July 12, 1945, April 20, 1948; Sta. 3A, May 3, 1946 (F). McMinnville, Fender home, November 10, 1942, April 14, May 15, 1945, May 26-29, 1948, chiefly at light (F); Corvallis, May 29, (Cole auct.); Willamette River, 3 miles south of Dayton, June 3, 1948 (F). Southern Oregon: Ashland-Lake of the Woods, June 10, 1945 (F). Cascades: Mount Hood-Cloud Cap Inn Junction, August 9, 1946 (F); Hood River, June 8 (Cole); Hood River Meadows, July 17, 1947 (A & F); Polally Forest Camp, 3,000 ft., August 9, 1946 (F); Robin Hood Forest Camp, 3,560 ft., July 17, 1947 (A); Timberline Lodge, 5,500 ft., August 7, 1946 (A). Cascadia, 800 ft., August 2, 1948 (A & F); Devils Garden, Century Drive, August 5, 1948 (A); Metolus River, August 3, 1948 (A & F); Tumalo Creek, Bend, 3,610 ft., August 14, 1948 (A). Crater Lake Park Headquarters, 6,500 ft., August 2, 1946 (A). Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F); Fremont National Forest, June 12, 1945 (F); French Glen, June 12, 1947 (F); Mountain Creek, August 16, 1948 (A); Ochoco National Forest, June 14, 1947 (F); Warner Lakes, June 12, 1947 (F). Blue Mts.: Spring Creek, 3,900 ft., June 5, 1949 (Baker); Huntington, June 17, 1939 (Knowlton); Lime, along Burnt River, 2,400 ft., June 17, 1939 (Knowlton), June 24, 1948 (A); Pendleton, July 5, 1948 (A); Starr Creek, Malheur National Forest, May 30, 1949 (Baker); Upper Walla Walla River, August 18, 1948 (A); Whitman National Forest, June 14, 1947 (F). Wallawas: Aneroid Lake Trail, 7,000 ft., July 26, 1949 (Baker); Enterprise, 4,200 ft., June 29, 1948 (A); Lazy T Ranch, July 13, August 28-31, 1949 (Sperry); Lostine Valley, 5,000 ft., July 1, 1948 (A).

Erioptera (Trimicra) pilipes (Fabricius, 1787), var.—Coast: Langlois, June 22, 1939 (Knowlton); Neskowin, August 17, 1948 (James). Willamette Valley: Henderson Bridge, June 16, 1948, May 22, 1949 (F).

Erioptera (Psiloconopa) bispinigera Alexander, 1930.—Cascades: Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Eastern Oregon: Malheur National Forest, Seneca, June 12, 1947 (F); Ochoco National Forest, June 14, 1947 (F). Blue Mts.: Spring Creek, 3,900 ft., June 25, 1948 (A). Little Phillips Creek, 2,850 ft., July 3, 1948 (A); Whitney, June 19, 1949 (Baker). Wallawas: Eagle Cap Wilderness Area, 5,000 ft., June 28, 1948 (A); Lostine, 3,375 ft., July 2, 1948 (A).

Erioptera (Psiloconopa) carbonipes Alexander, 1929.—Willamette Valley: Henderson Bridge, 2 miles west of Amity, June 16, 1948, May 22, 1949 (F).

Erioptera (Psiloconopa) irata Alexander, 1949.—Coast: Eel Creek Forest Camp, August 11, 1948 (F). Willamette Valley: Peavine, Sta. 1, April 23, July 26, 1946, June 19, 1947 (F). Happy Valley, McMinnville, April 14, August 6, 1946 (F); Hendersons Bridge, May 22, 1949 (F); Panther Creek, McMinnville, July 14-25, 1948, May 23, 1949 (F). Cascades: Hazel Creek, near Dexter, July 15, 1947 (A); Westfir, 1,000 ft., August 5, 1946 (A).

Erioptera (Psiloconopa) manitobensis Alexander, 1929.—Blue Mts.: Dixie, May 18, 1949 (Davis); Lime, Burnt River, 2,400 ft., June 24, 1948 (A); Pendleton, Umatilla River, July 5, 1948 (A); Upper Walla Walla River, above Milton, 1,275 ft., July 4, 1948 (A).

Erioptera (Psiloconopa) megarhabda (Alexander, 1943).—Cascades: Cascadia, 800 ft., August 2, 1948 (A & F); Trout Creek Forest Camp, 1,245 ft., August 2, 1948 (A). Blue Mts.: Little Phillips Creek, 2,850 ft., July 2, 1948 (A).

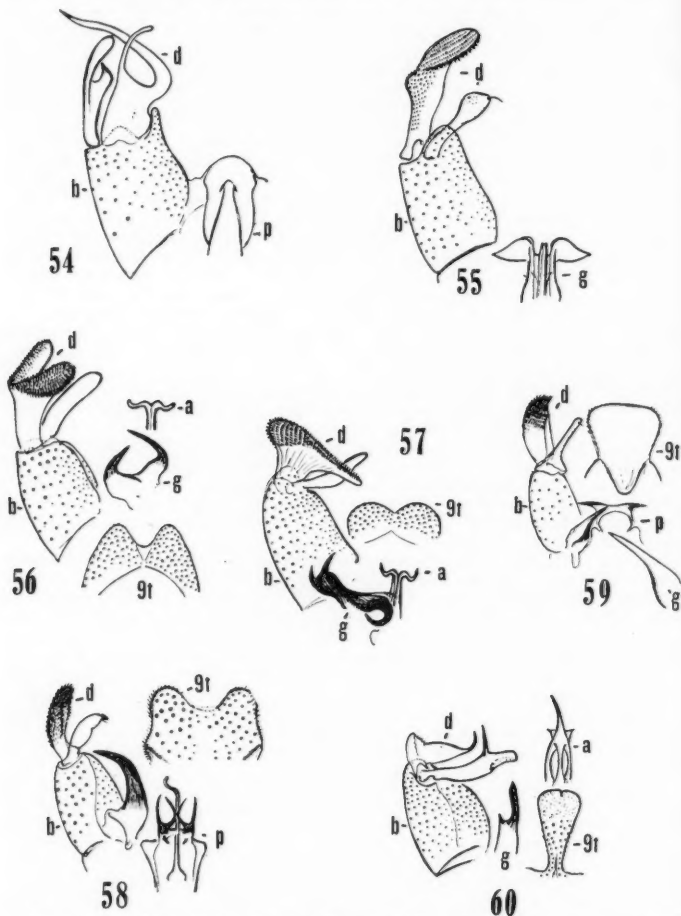
Erioptera (Psiloconopa) rainieria Alexander, 1943.—Cascades: Dutchman's Flat, 6,100 ft., August 5, 1948 (A & F); Little Deschutes River, August 4, 1946 (A); Odell Lake, Lazy Creek, 4,800 ft., August 4, 1946 (A). Crater Lake-Lost Creek, 5,900 ft., August 2, 1946 (A); Pole Creek Meadows, 5,900 ft., August 3, 1946, August 7, 1948 (A). Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F).

Erioptera (Psiloconopa) shoshone Alexander, 1945.—Willamette Valley: Willamette River, near Dayton, on gravel bars, April 17, 1949 (F). Wallawas: Johnson Park, Wallawa River, 2,750 ft., August 18, 1948 (A).

Erioptera (Psiloconopa) unduligera Alexander, 1945.—Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F); type.

Erioptera (Psiloconopa) zukeli Alexander, 1940.—Blue Mts.: Upper Walla Walla River, 1,450 ft., July 4, August 17, 1948 (A). Wallows: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (A).

Erioptera (Hesperoconopa) dolichophallus Alexander, 1948.—Cascades: Mount Hood-Horsethief Meadows, 3,400 ft., July 18, 1947 (F); Robin Hood Camp, 3,560 ft., July 18, 1947, along margins of the Hood River (F); Sahale Falls, 4,575 ft., July 17, 1947, July 31, 1948 (F); Salmon River, July 30, 1948 (F); Scill Creek, July 16, 1947 (A & F). Metolius River, 2,600 ft., June 14, 1945, August 3, 1948 (F).



Figs. 54-60.—Male hypopygia: 54. *Erioptera (Empeda) alicia* Alexander. 55. *E. (Erioptera) oregonensis* Alexander. 56. *Ormosia (Rhypholophus) oregonica* Alexander. 57. *O. (Rhypholophus) hoodiana* Alexander. 58. *O. (Ormosia) albrighti* sp. nov. 59. *O. (Ormosia) buccera* sp. nov. 60. *O. (Ormosia) curvata* Alexander (See fig. 1 for explanation of symbols).

Erioptera (Hesperoconopa) pilipennis Alexander, 1918.—Cascades: Hood River, June 2, 1917 (through Cole); type.

Ormosia (Rhypholophus) bifidaria Alexander, 1919.—Cascades: Mount Hood-Timberline Lodge, 5,500 ft., August 7, 1946 (A & F); among mountain hemlock and limber pine, swept from beds of bear grass and *Calochortus*. Dutchman's Flat, 6,100 ft., August 5, 1948 (A). Blue Mts.: Anthony Lake, 7,000 ft., June 27, 1948 (A & Baker).

Ormosia (Rhypholophus) fumata (Doane, 1900).—Coast: High Heaven, July 12, 1949 (F); Saddle Mountain State Park, July 24, 1949 (F). Cascades: Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., August 29, 1948 (Baker); Langdon Lake 4,990 ft., August 16, 1948 (A).

Ormosia (Rhypholophus) hoodiana Alexander, 1944.—Cascades: Mount Hood-Hood River, July 29, 1921 (Melander), types; Hood River Meadows, 4,480 ft., July 17 1947 (A & F).

Male hypopygium (Fig. 57) with the outer dististyle, *d*, large, its lower angle greatly extended and narrowed, the surface, especially of the outer angle, covered with scales arranged in parallel rows. Inner dististyle narrow, gently curved. Gonapophyses, *g*, appearing as two strong plates that form a virtually continuous straight angle, the outer arms blackened, bispinuous, the mesal portion produced into a strongly curved slender hook. Branches of aedeagus, *a*, short.

Ormosia (Rhypholophus) oregonica Alexander, 1944 (*fugax* Alexander, 1946).—Willamette Valley: Peavine, Sta. 3, September 10-18, 1945 (F), types of *fugax*. Cascades: Hazel Creek, near Dexter, August 5, 1946 (A); Willis Creek, North Santiam, August 17, 1947 (F). Crater Lake, 6,400-6,600 ft., August 29, 1930 (Scullen), type of *oregonica*.

Male hypopygium (Fig. 56) with the caudal margin of the tergite, *9t*, deeply notched. Outer dististyle, *d*, broadly expanded, the two apical lobes not greatly different in size, provided with unusually abundant and dense black spinous setae. Inner dististyle a relatively broad flattened blade. Gonapophysis, *g*, bispinuous, the outer spine slender and simple (*fugax*) or unequally bispinuous (*oregonica*); inner spine longer, strongly bent near base. Branches of aedeagus, *a*, relatively short.

Ormosia (Rhypholophus) paradisea Alexander, 1920 (*garretti* Alexander, 1926).—Cascades: Mount Hood-Sahale Falls, 4,575 ft., July 17, 1947 (F); Tilly Jane Creek, 5,600-5,700 ft., July 18, 1947, July 29-30, 1948 (A & F); abundant, swarming, in cases very close to banks of melting snow.

Ormosia (Rhypholophus) suffumata Alexander, 1943.—Blue Mts.: Spring Creek, 3,900 ft., September 6-19, 1948 (Baker). Wallows: Lostine Valley, 5,500 ft., August 18, 1948 (A).

Ormosia (Ormosia) absaroka Alexander, 1943.—Willamette Valley: Peavine, no station, May 5, 1945, on sword fern (F). Cascades: Mount Hood-Tilly Jane Creek, 5,600 ft., July 29, 1948 (A); Timberline Lodge, 5,500 ft., July 16, 1947, swept from fir and mountain hemlock (A & F). Crater Lake-Annie Creek, 6,000 ft., August 1, 1946 (A); Lake Trail, 6,200-6,600 ft., July 12, 1947 (A). Blue Mts.: Spring Creek, 3,900 ft., April 26, 1949 (Baker); Anthony Lake, 7,000 ft., June 27, 1947, swept from beds of *Allium* and *Saxifraga* in boggy area (A & Baker); Langdon Lake, 4,970 ft., July 2, 1948; a single very large specimen swept from marsh vegetation (A).

Ormosia (Ormosia) albertensis Alexander, 1933.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., August 8, 1946 (A & F); Robin Hood Camp, 3,560 ft., August 8, 1946 (A & F). Little Deschutes River, August 4, 1946 (A); Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A). Crater Lake-Annie Creek, 6,000 ft., August 1-3, 1946 (A). Wallows: Aneroid Lake Trail, 7,000 ft., July 26, 1949 (Baker).

Ormosia (Ormosia) albrighti sp. nov.—Belongs to the *similis* group; thorax very pale buffy yellow; antennae elongate; wings grayish subhyaline, the veins pale brown, relatively inconspicuous; cell M_2 open by the atrophy of the basal section of M_3 ; Anal veins convergent; male hypopygium with a single very powerful blackened horn on mesal face of basistyle; phallosome relatively small, consisting of a blackened central plate, each outer lateral angle of which is produced into two slender spines.

♂. Length, about 5 mm.; wing, 5.8 mm.

Rostrum and palpi brown. Antennae with scape and pedicel yellow; first flagellar segment elongate, brown; remainder of antenna broken but it is evident that the organ is elongate. Head above dark gray.

Thorax very pale buffy yellow, only a little darker than the pretergites. Halteres with stem pale, knob very weakly darkened. Legs with the coxae and trochanters yellow;

remainder of legs obscure yellow, the femoral tips more darkened. Wings grayish subhyaline, the stigmal region darker; veins pale brown, relatively inconspicuous. Venation: Cell M_2 open by atrophy of basal section of M_3 ; vein 2nd A sinuous on more than the outer third.

Abdomen, including hypopygium, medium brown. Male hypopygium (Fig. 58) with the caudal margin of tergite, $9t$, broadly emarginate, the lobes obtuse. Mesal face of basistyle, b , bearing a single very powerful blackened horn from an expanded base, the horns directed caudad and slightly outward. Outer dististyle, d , relatively long, with abundant blackened scalelike setae over most of their length. Inner dististyle a pale blade, blackened and acute at apex. Phallosome, p , relatively small, as compared with the horn of the basistyle, consisting of a blackened central plate, the outer lateral angle produced caudad into two slender spines, the outer and less curved one pale at tip. Aedeagus long and slender, very strongly bent near apex.

Holotype, ♂, Salt Creek Falls, 3,800 ft., July 14, 1947 (C. P. Alexander); on wet rocky ledges along trail to the foot of the falls.

I am pleased to name this fly for Mr. Ray Albright, to whom I am much indebted for various interesting Oregon Tipulidae. The closest relative is *Ormosia* (*Ormosia*) *furibunda* sp. nov. which is readily told by the quite different male hypopygium.

***Ormosia* (*Ormosia*) *bucera* sp. nov.**—Allied to *leptorhabda*; thorax almost uniformly brownish yellow, scarcely patterned; wings with a strong fulvous brown suffusion; cell M_2 open by the atrophy of m ; male hypopygium with the tergite broad, the caudal border truncate; outer dististyle a flattened scooplike structure, its apex broadly truncate; phallosome with a depressed central plate whose outer angles are produced laterad into strong spines; apophyses appearing as even larger spines that are directed mesad and caudad.

♂. Length, about 4.5-4.7 mm.; wing, 4.7-5 mm.

Rostrum and palpi brownish black. Antennae broken. Head dark brown.

Thorax almost uniformly brownish yellow, scarcely patterned; pseudosutural foveae pale, tuberculate pits more evident, reddish brown. Pleura somewhat clearer yellow than the dorsum. Halteres with stem pale, knob infuscated. Legs with coxae and trochanters yellow, remainder of legs brownish yellow. Wings with a strong fulvous brown suffusion, the prearcular and costal regions somewhat clearer yellow; stigmal region pale brown, inconspicuous; veins pale brown, more brownish yellow in the brightened fields. Venation: R_{2+3+4} longer than basal section of R_5 ; cell M_2 open by atrophy of m ; $m-cu$ about one-fourth its length beyond the fork of M ; Anal veins divergent.

Abdominal tergites brown, the sternites more yellowed; hypopygium yellow. Male hypopygium (Fig. 59) with the tergite, $9t$, broad, slightly expanded outwardly, the caudal border truncate, with very short and inconspicuous fimbriations, those of the sides longer and more evident. Outer dististyle, d , a flattened scooplike structure, its apex truncate, the surface with rows of blackened spinous setae, some of which are larger and more conspicuous. Inner dististyle a broad-based structure that narrows abruptly into a long straight rod, the tip obtuse; lower surface with scattered setae, including a larger one near tip. Phallosome, p , having the depressed central plate with its outer angles produced laterad into strong spines; on either side of the phallosome with even larger spines that are directed mesad and caudad.

Holotype, ♂, Beaver Creek, Mount Hood, 1,150 ft., August 7, 1946 (C. P. Alexander). *Paratopotype*, a broken ♂, July 16, 1947 (Alexander & Fender); *paratypes*, ♂ ♂, Bear Creek, 1,400 ft., August 1, 1948 (C. P. Alexander).

Most nearly allied to *Ormosia* (*Ormosia*) *leptorhabda* Alexander, 1943, differing in the details of structure of the male hypopygium.

Ormosia (*Ormosia*) *curvata* Alexander, 1924.—Coast: Grand Ronde, March 31, 1949 (F). Willamette Valley: Peavine, Sta. 2, March 21, 1947 (F).

Male hypopygium (Fig. 60) with the tergite, $9t$, large, its appendage elongate-triangular in outline, the base narrow, the apex with a narrow median split; outer third of lobe with abundant fimbriations, the basal half with fewer but larger setae. Basistyle, b , projecting slightly beyond the point of insertion of the dististyles. Outer dististyle, d , consisting of a scooplike base and an extended outer part that narrows into a strong curved hook. Inner dististyle larger, appearing as a stout arm, its outer margin beyond midlength with a long acute black spine; lower margin of apex beyond this point with pale membrane. Gonapophysis black, unequally bispinous, the outer spine a small acute

point. Aedeagus, a , unusually small and weak, especially the slender apex, the latter at base with a flattened plate that is extended into small lateral points.

Ormosia (Ormosia) davisi sp. nov.—Belongs to the *similis* group, allied to *unicornis*; male hypopygium with the outer arm of the outer dististyle a curved black rod that bears two or three strong appressed spines; inner arm short-stemmed, the apex a broadly flattened blade that is extended into two powerful spines; inner dististyle a long slender rod, at near midlength of outer face bearing an erect spine.

♂. Length, about 4.5 mm.; wing, 5.2 mm.; antenna, about 1.1 mm.

Rostrum and palpi black. Antennae short, black; flagellar segments with long verticils and a shorter abundant whitish pubescence. Head dark brown.

Thoracic notum almost uniformly dark grayish brown, the pretergites not brightened; postnotum and pleura slightly paler. Halteres yellow. Legs with the coxae pale brown; trochanters yellow; remainder of legs brown, femoral bases obscure yellow, broadest on the posterior legs. Wings tinged with brown, the prearcular field more yellowed; stigma darker brown; veins brown, those at the base pale. Venation: R_{2+3} subequal to vein R_2 ; cell M_2 open by the atrophy of basal section of vein M_3 ; Anal veins divergent, vein 2nd A virtually straight.

Abdomen dark brown. Male hypopygium (Fig. 63) with the median lobe of tergite, 9i, elongate, narrowed at base, gently widened outwardly, the apex bilobed by a median notch (this probably broader than figured, due to deformation on slide). Basistyle, b , at apex produced into a stout lobe. Dististyles, d , subterminal, the outer one profoundly bilobed, the outer arm a curved black rod that bears two or three strong appressed spines; inner arm short-stemmed, the apex a broadly flattened blade that extends into two powerful spines, as figured. Inner dististyle a long slender rod, at near midlength of outer face bearing an erect spine, the apex of the style beyond this point more membranous, especially on the lower half. Gonapophysis, g , terminating in two unequal spines, the axial one much longer and stouter.

Holotype, ♂, Silver Creek Falls, 1,000 ft., July 8, 1949 (K. M. Fender).

This interesting *Ormosia* is named for Mr. John E. Davis, to whom I am indebted for several interesting Tipulidae from many parts of Oregon. It is closest to *Ormosia (Ormosia) unicornis* sp. nov., which differs in the details of structure of the male hypopygium, particularly the entire outer arm of the outer dististyle.

Ormosia (Ormosia) decussata Alexander, 1924.—Coast: Cannon Beach, August 6, 1940 (Townes); High Heaven, July 12, 1949 (F); Salmon River, near Boyer, August 12, 1948 (F). Willamette Valley: Peavine, no station, September 18, October 12, 1945; Sta. 3A, July 24, 1948 (F). Silver Creek Falls, August 2, 1948 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (A). Metolius River, August 3, 1948 (A & F).

Ormosia (Ormosia) defrenata Alexander, 1948.—Blue Mts.: Spring Creek, 3,900 ft., August 29, 1948 (Baker). Wallawas: Lostine Valley, above French Forest Camp, 5,500 ft., August 19, 1948 (A).

Ormosia (Ormosia) divergens (Coquillett, 1905).—Cascades: Mount Hood-North Fork of Iron Creek, 4,400 ft., July 31, 1948 (A). Wallawas: Spring at Power Plant, Wallawa Creek, 4,675 ft., June 29, 1948 (A); Hurricane Creek, 5,460 ft., July 11, 1949 (Sperry).

Ormosia (Ormosia) flaveola (Coquillett, 1900).—Coast: High Heaven, April 1, 1949 (F). Willamette Valley: Silver Creek Falls, May 9, 1948, July 8, 1949 (F).

Ormosia (Ormosia) furibunda sp. nov.—Belongs to the *similis* group; general coloration of the thoracic dorsum medium brown; antennae (male) elongate, nodulose; wings with cell M_2 open by atrophy of basal section of M_3 ; vein 2nd A strongly sinuous on outer third; male hypopygium with the phallosome consisting of two pairs of heavily blackened rods or apophyses, the smaller inner pair bearing a slender lateral branch; outer portion of aedeagus strongly sinuous.

♂. Length, about 4.5-5 mm.; wing, 5.2-6 mm.; antenna, about 3.3-5 mm.

Rostrum and palpi brown. Antennae (male) elongate, nearly two-thirds as long as the wing; scape and pedicel obscure yellow, flagellum brownish black; flagellar segments swollen basally, narrowed on more than the outer half; longest verticils unilaterally distributed, a trifle exceeding the segments. Head dark brown.

Thorax medium brown, without evident pattern; lateral praescutal borders and the pleura more brownish yellow to obscure yellow. Halteres pale, knobs weakly darkened. Legs with the coxae and trochanters obscure yellow; remainder of legs yellow, the tarsi

passing into dark brown. Wings (Fig. 61) with a weak brownish tinge, the stigma darker brown; costal border slightly more infuscated than remainder of ground; veins brown. Venation: Cell M_2 open by atrophy of basal section of M_3 ; vein 2nd A strongly sinuous on outer third.

Abdomen, including hypopygium, dark brown. Male hypopygium (Fig. 62) with the tergite, 9t broad, the caudal margin with a broad V-shaped notch, the lateral lobes broad. Outer dististyle, d , small, the setae or setoid spines that form the vestiture very small. Inner dististyle obtuse at tip. Phallosome, p , complex, comprised of two pairs of gonapophyses, these heavily blackened, the outer pair larger; inner apophyses bearing a small lateral branch that becomes pale on its outer half. Aedeagus, a , slender, straight on more than the basal half, the outer portion strongly sinuous.

Holotype, ♂, Peavine Ridge, Station 3A, July 5, 1946 (K. M. Fender). *Paratypes*, 2 ♂♂; 1 ♂, June 27, 1949 (K. M. Fender).

Ormosia (Ormosia) furibunda is readily told from all other regional species having elongate nodulose antennae in the male by the structure of the hypopygium, particularly the complex phallosome. In its general appearance it is most like *O. (O.) decussata* Alexander, *O. (O.) longicornis* (Doane), and *O. (O.) pugetensis* Alexander, yet is entirely distinct from all.

Ormosia (Ormosia) fusiformis (Doane, 1900).—Coast: Saddle Mt. (Boyer), October 26, 1935 (Dirks-Edmunds). Willamette Valley: Peavine, Sta. 1, June 20, 1946, May 22, June 24, 1947; Sta. 2, April 26, 1947; Sta. 3, July 2, September 13, October 28, 1946, May 3, 1947, May 25, June 29, 1948, June 6, 1949; Sta. 3A, July 12, October 10, 1945, May 15, June 19, October 3-18, 1946, May 5-23, June 17, 1947, July 16, September 10, 1948; Sta. 4, April 19, 1947 (F). Happy Valley, McMinnville, May 12, August 6, 1946 (F); McMinnville, May 16, 1945, on skunk cabbage (F); Silver Creek Falls, July 8, 1949 (F). Cascades: Mount Hood-Bear Creek, 1,400 ft., August 1, 1948 (A & F); Still Creek, 3,600 ft., July 16, 1947, July 31, 1948 (F); Wapinitia Cutoff, August 7, 1946 (F). Indian Ford, 3,240 ft., August 5, 1948 (A & F); Metolius River, 2,600 ft., August 3, 1948 (A & F); Willis Creek, August 17, 1947 (Albright). Blue Mts.: Langdon Lake, 4,990 ft., July 2, 1948 (A); Little Phillips Creek, 2,850 ft., July 3, 1948 (A); Upper Walla Walla River, above Milton, 1,275 ft., July 4, 1948 (A).

Ormosia (Ormosia) gerronis sp. nov.—Belongs to the *similis* group; mesonotum reddish brown, dorsal pleurites weakly infuscated, the more ventral ones yellowed; antennae (male) of moderate length; wings with cell M_3 open by atrophy of basal section of M_2 . Anal veins convergent; male hypopygium having the phallosome consisting of a central blackened rod, at near midlength produced laterad into short-triangular blackened spines.

♂. Length, about 5 mm.; wing, 5.5 mm.

Rostrum brown; palpi black. Antennae (male) with scape brownish yellow, the succeeding three segments dark brown, the remainder broken; basal two flagellar segments long-fusiform, with long verticils; the organ, when entire, evidently reaching backward at least to base of abdomen. Head dark brown.

Pronotum light brown, the scutellum and pretergites pale yellow. Mesonotum chiefly reddish brown, the humeral region of praescutum a little more brightened; praescutum with indications of three darker stripes, the median one deeper in front. Dorsal pleurites and ventral half of pleurotergite weakly infuscated, the ventral pleurites and dorsopleural membrane yellow. Halteres infuscated. Legs with the coxae and trochanters pale yellow; remainder of legs brown to dark brown. Wings with a weak brownish tinge, the stigmal region still darker; veins pale brown. Venation: Sc_1 ending nearly opposite R_2 ; R_{2+3+4} about one-half longer than the basal section of R_5 ; cell M_2 open by the atrophy of basal section of M_3 ; Anal veins convergent.

Abdomen, including hypopygium, dark brown. Male hypopygium (Fig. 65) with the caudal margin of tergite, 9t, with a shallow U-shaped notch, the lateral lobes relatively broad, truncated at tips, the outer margin narrowly dusky. Basistyle, b , on mesal face with two unequal spines, the more caudal one larger, directed backward, the small slender anterior spine directed mesad and then caudad. Phallosome, p , of distinctive form, consisting essentially of a central blackened rod, at near midlength produced laterad into short-triangular blackened spines; central produced portion before apex with a small subterminal spine on either side.

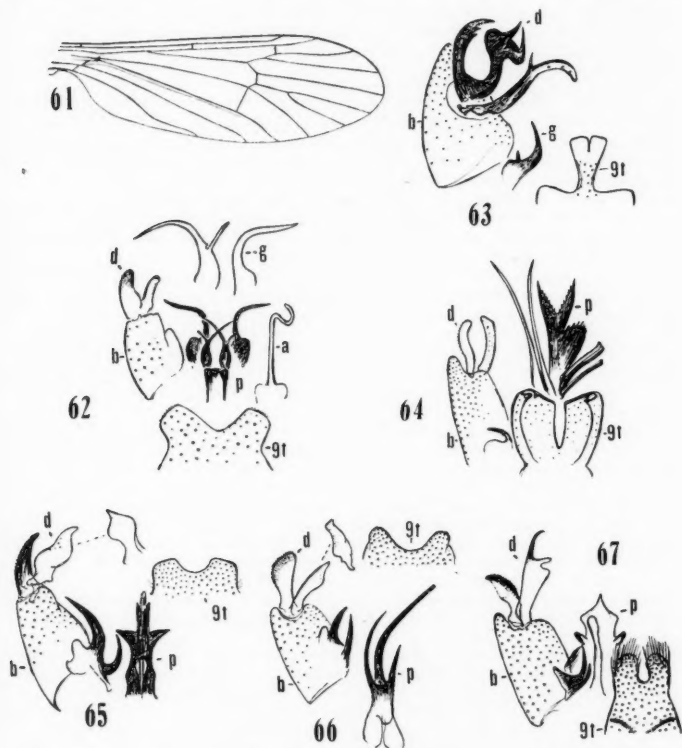
Holotype, ♂, Humberg Mountain State Park, August 11, 1948 (K. M. Fender).

Most similar to *Ormosia (Ormosia) heptacantha* Alexander and *O. (O.) nonacantha* sp. nov., differing chiefly in the details of structure of the male hypopygium.

Ormosia (Ormosia) hallahani Alexander, 1943.—Cascades: Metolius River, 2,600 ft., June 14, 1945 (F).

Ormosia (Ormosia) hispa Alexander, 1945.—Willamette Valley: Peavine, Sta. 1, June 4, July 3, 1946, May 15-27, June 19, 1947; Sta. 2, June 4-27, July 6, 1946; Sta. 3A, June 11, 1946 (F). McMinnville, July 2, 1949 (F); Panther Creek, McMinnville, May 23, 1949 (F).

Male hypopygium (Fig. 64) with the tergite, *gt*, very large, pale, scooplike, profoundly divided into two halves by a deep notch, the inflexed margin of each half with two lobes or denticles. Both dististyles, *d*, of approximately the same size, the outer pale, its surface with delicate setulae; inner style a darker rod, its apex obliquely obtuse, the surface with scattered microscopic punctures. Phallosome, *p*, conspicuous, consisting of two elongate narrow ribbonlike blades that jut far beyond the other elements, gradually narrowed into needlelike points; in addition, a heavy blackened central mass, consisting of a ribbed central plate that is forked at tip, on its lower margin with a very high similarly ribbed crest or flange, in slide mounts directed laterad, as figured, the margin erose or irregularly toothed; two further darkened rods near base of phallosome, the upper one



Figs. 61-67.—61. *Ormosia (Ormosia) furibunda* sp. nov., venation. 62-67. Male hypopygia: 62. *Ormosia (Ormosia) furibunda* sp. nov. 63. *O. (Ormosia) davisii* sp. nov. 64. *O. (Ormosia) hispa* Alexander. 65. *O. (Ormosia) gerronis* sp. nov. 66. *O. (Ormosia) nonacantha* sp. nov. 67. *O. (Ormosia) perspectabilis* Alexander (See fig. 1 for explanation of symbols).

larger. Gonapophysis with the blackened spinous lobe microscopically ribbed or roughened.

Ormosia (Ormosia) manicata (Doane, 1900) (*deviata* Dietz, 1916; *fuscipyga* Alexander, 1924).—Coast: High Heaven, July 12, 1949 (F); Tahkenitch Lake, August 5, 1940 (Towner). Willamette Valley: Peavine, Sta. 1, April 23, June 20, July 3-18, 1946, May 15, 1947, July 2, 1948, June 6, July 7, 1949; Sta. 3, May 7, June 19, July 17, September 10-12, 1945, September 13, 1946, July 8, 1947, July 2, 1949; Sta. 3A, July 14, 1948 (F). McMinnville, May 30, 1948, July 2, 1949; Muddy Valley, McMinnville, May 9, 1945; Panther Creek, McMinnville, July 25, 1948 (F). Silver Creek Falls, August 2, 1948 (F); Willamette River, Dayton, April 24, 1949 (F). Cascades: Mount Hood-Clackamas Lake, 3,300 ft., August 8, 1946 (A & F); Robin Hood Forest Camp, 3,560 ft., August 8, 1946, July 17, 1947 (A & F). Blue Mts.: Spring Creek, 3,900 ft., June 24, September 19, October 17, 1948, June 15, 1949 (Baker); Upper Walla Walla River, near Milton, 1,275 ft., July 4, August 18, 1948 (A).

Ormosia (Ormosia) modica (Dietz, 1916) (*stylifer* Alexander, 1919).—Coast: High Heaven, June 22, 1945 (F). Willamette Valley: Peavine, Sta. 1, May 2, June 4, July 1, 1946, May 15-22, 1947, May 22, June 2, 1948; Sta. 2, May 26, 1947; Sta. 3A, May 23-29, June 30, 1947, June 15-30, 1948, June 27, 1949 (F). Forest Grove, June 3 (Cole), type of *stylifer*; Hendersons Bridge, May 22, 1949 (F); McMinnville, skunk cabbage association, May 16, 1945, May 26-29, 1948, July 2, 1949 (F); Muddy Valley, McMinnville, May 9, 1945 (F); Willamette River, south of Dayton, June 4, 1948 (F); Zena, June 5, 1948 (F).

Ormosia (Ormosia) nonacantha sp. nov.—General coloration pale reddish brown; antennae (male) elongate; wings with a weak brownish tinge; cell M_2 , open by atrophy of basal section of M_3 ; male hypopygium with two strong black spines on mesal face of basistyle; phallosome consisting of five long blackened rods or spines, including two pairs of apophyses and the central aedeagus.

♂. Length, about 4.5 mm.; wing, 4.5 mm.; antenna, about 3 mm.

Rostrum and palpi brownish black. Antennae (male) dark brown or brownish black, elongate, approximately two-thirds the body or wing; flagellar segments fusiform, with unusually long outspreading white setae. Head brownish gray.

Thoracic dorsum almost uniformly pale reddish brown, the cephalic portion of praescutum very vaguely pruinose and slightly more darkened; pleura clearer yellow. Halteres infuscated, the base of stem narrowly yellow. Legs with coxae and trochanters pale yellow; remainder of legs broken. Wings with a weak brownish tinge, the prearcular and costal fields, with the stigma, a trifle more darkened; veins brownish yellow. Venation: R_2 subequal in length to R_{2+3} ; cell M_2 open by atrophy of basal section of M_3 ; $m-cu$ about one-fifth its length before the fork of M ; Anal veins slightly convergent, the distal third of 2nd A sinuous.

Abdomen, including hypopygium, medium brown. Male hypopygium (Fig. 66) with the caudal margin of tergite, 9t, with a broad and shallow emargination, the lateral lobe thus formed unusually narrow. Basistyle, b, on mesal face with two strong black spines, the more caudal one stouter and slightly more curved. Phallosome, p, consisting of five long blackened rods or spines, the longest being interpreted as being the aedeagus; the remaining four spines are paired (a single pair shown in figure), the ventral spine longer, more slender and slightly curved, the upper spines straight, all acute at tips.

Holotype, ♂, Humburg Mountain State Park, August 11, 1948 (K. M. Fender).

Among the various species of *Ormosia* having a pair of spines on each basistyle of the male hypopygium, the present fly is closest to the more southern *Ormosia (Ormosia) burneyensis* Alexander and O. (O.) *heptacantha* Alexander, differing conspicuously in the structure of the phallosome.

Ormosia (Ormosia) onerosa Alexander, 1943.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 31, 1948 (A); North Fork of Iron Creek, July 31, 1948 (F); Sahale Falls, 4,575 ft., July 31, 1948 (A); Tilly Jane Creek, 5,700 ft., July 30, 1948 (A & F). Dutchman's Flat, 6,300 ft., August 5, 1948 (F); Elk Lake, 4,900 ft., August 6, 1948 (A). Crater Lake-Pole Creek Meadows, 5,900 ft., August 7, 1948 (A).

Ormosia (Ormosia) perspectabilis Alexander, 1944.—Coast: Saddle Mt. (Boyer), September 29, October 13, 1934, October 6, 1935, September 20, 1936 (*Macnab and associates*); types.

Male hypopygium (Fig. 67) with the ninth tergite, 9t, broad-based, narrowed into the apical lobe which is deeply notched by a rounded emargination; lobes with conspicuous setae and fimbriations, the outer ends of lobes paler and more membranous. Basistyle with the lateral apophyses on mesal face, b, appearing as a sclerotized rod that is extended

into two unequal black spines, the small more cephalic one closely appressed to the major spine. Remainder of phallosome, *p*, a depressed-flattened plate that terminates in an acute point, on lateral margin of the plate with a small blackened lobe. Outer dististyle, *d*, small, its outer apical portion blackened and provided with microscopic appressed points, the apex below this pale and membranous to present a notched appearance. Inner dististyle much larger, terminating in a conspicuous black outer spine and a slightly shorter pale fingerlike lobe that bears a few microscopic punctures.

Ormosia (Ormosia) pleuracantha sp. nov.—Size relatively large (wing, male, over 5.5 mm.); general coloration dark plumbeous gray; antennae (male) relatively elongate; wings with a brownish tinge, the stigma darker brown; cell *M*₅ open by atrophy of basal section of *M*₃; vein 2nd *A* sinuous on more than the outer third; male hypopygium with the tergite only shallowly emarginate; mesal portion of basistyle with a blackened bispinuous plate; outer dististyle black, bispinuous; gonapophyses appearing as small yellow blades that narrow to the acute tips.

♂. Length, about 4.6-5 mm.; wing, 5.6-6 mm.; antenna, about 2.3-2.5 mm.

Rostrum and palpi black. Antennae (male) relatively long, approximately one-half the length of body, black throughout; flagellar segments elongate, more narrowed at the ends, especially the outer end; longest verticils of the intermediate segments a little less than twice the segments. Head dark gray.

General coloration of thorax dark plumbeous gray, the praescutal stripes very poorly indicated; pretergites obscure yellow; pseudosutural foveae blackened. Halteres yellow, the knobs weakly more darkened. Legs with the coxae testaceous yellow; trochanters yellow; remainder of legs obscure yellow, the tips of the femora and tibiae a little more darkened; tarsi brown. Wings (Fig. 68) with a brownish tinge, the stigma darker brown, preceded and followed by somewhat paler areas; costal border, except before the stigma, infuscated; prearcular field more yellowed; veins stout, brown, yellowed in the prearcular area. Venation: *R*₂ a little longer than *R*₂₊₃; cell *M*₅ open by atrophy of basal section of *M*₃; vein 2nd *A* sinuous on more than the outer third.

Abdomen, including the hypopygium, black. Male hypopygium (Fig. 69) with the tergite, *9t*, extensive, the caudal border only feebly emarginate, with low pale lateral lobes that are densely provided with delicate silken setae, with stronger yellow bristles more basad, the latter decussate at the midline. Basistyle, *b*, with the mesal face bearing a blackened bispinuous plate, the outer spine about one-half longer and somewhat stouter than the cephalic one. Outer dististyle, *d*, a heavily blackened bispinuous plate. Inner dististyle larger, pale yellow, the membrane without sensory pores, such as are found in many species of the *similis* group. Gonapophysis, *g*, appearing as small narrow yellow blades that narrow to the acute tips; aedeagus even smaller, narrowed to the apex.

Holotype, ♂, Peavine Ridge, Station 1, June 20, 1946 (K. M. Fender). *Paratopotypes*, ♂♂, June 20-26, 1946, June 24, July 3, 1947 (Fender); *paratype*, ♂, State Line Creek, southern Oregon on California border, August 9, 1948 (C. P. Alexander).

This fly is especially distinct from the other described species, differing especially in the structure of the male hypopygium, particularly the tergite, basistyle, and the dististyles. Superficially it most resembles species such as *Ormosia (Ormosia) lanuginosa* (Doane).

Ormosia (Ormosia) profunda Alexander, 1943.—Coast: Pacific City, May 23, 1948 (F).

Male hypopygium (Fig. 70) with the tergal lobe, *9t*, profoundly bilobed by a relatively narrow median split, the entire surface of the lobe with long scattered setae from conspicuous punctures. Basistyle, *b*, produced slightly beyond level of point of insertion of the dististyles as a short slender lobe. Outer dististyle, *d*, pale, its surface with delicate setulae, unequally bilobed by a deep marginal notch, the longer blade narrowed to the tip. Inner dististyle dark-colored, irregular in outline, the outer half more expanded, at near midlength with a small darkened point or tooth; outer margin roughened by numerous wartlike tubercles. Gonapophyses appearing as curved black hooks, as in the *manicata* group. Phallosome, *p*, yellow horn color, consisting of two equal narrow blades, acute at tips, and a shorter flattened central lobe, the apex of which is microscopically fimbriate or roughened.

Ormosia (Ormosia) proxima Alexander, 1924.—Cascades: Mount Hood-Horsethief Meadows, 3,400 ft., July 18, 1947 (A & F); Sahale Falls, 4,575 ft., July 17, 1947, July 31, 1948 (A & F). Wallows: Wallowa Creek, 4,635 ft., June 27-28, 1948 (A).

Male hypopygium (Fig. 71) with the tergal lobe, *9t*, widened outwardly, the apex bilobed. Outer dististyle a darkened blade, expanded outwardly, the margin usually four-toothed, in cases merely three-toothed. Inner dististyle, *d*, larger, the outer apical angle

produced into a sharp point or spine, the lower angle pendant, bilobed at tip. Gonapophysis, *g*, unequally bispinous, the inner spine much longer and stronger, gently curved. Aedeagus, *a*, very long and slender.

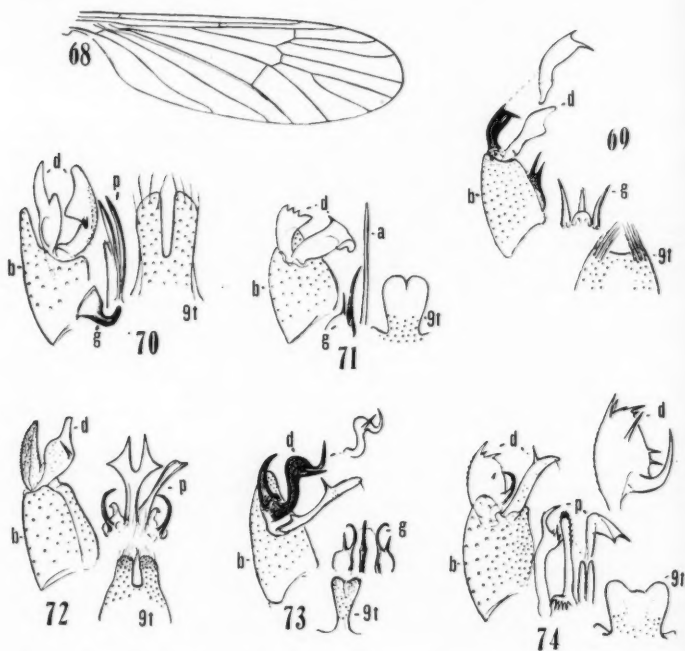
The most similar described species is *Ormosia (Ormosia) fragmentata* Alexander, 1940, of northern Korea.

Ormosia (Ormosia) pugetensis Alexander, 1944.—Willamette Valley: Peavine, Sta. 3, September 13, 1946 (F). Cascades: Mount Hood-Still Creek, 3,600 ft., July 17, 1947, July 31, 1948 (A).

Ormosia (Ormosia) subcornuta Alexander, 1920.—Coast: Grand Ronde, March 31, 1949 (F); Wallace Bridge, March 31, 1949 (F). Willamette Valley: Peavine, Sta. 2, March 21, 1947 (F). Forest Grove, March 20-26, 1919 (Cole), type material; Hillsboro, April 1, 1919 (Cole), type. Cascades: Westfir, 1,000 ft., August 5, 1946 (A).

Male hypopygium (Fig. 74) with the outer dististyle, *d*, a strongly bispinous plate, the extremes of armature in various specimens being shown, in the more accentuated cases with the discal spine long and slender, in other cases so reduced as to be barely visible. Inner dististyle with the spine lying far distad, only a little more than its own length before the tip. Phallosome, *p*, complex, about as figured (only three elements shown, or one-half of the whole structure).

The present fly is wide-spread over the Vancouverian region. The Rocky Mountain *Ormosia (Ormosia) sentis* Alexander, 1943, presumably represents a geographic race of this species.



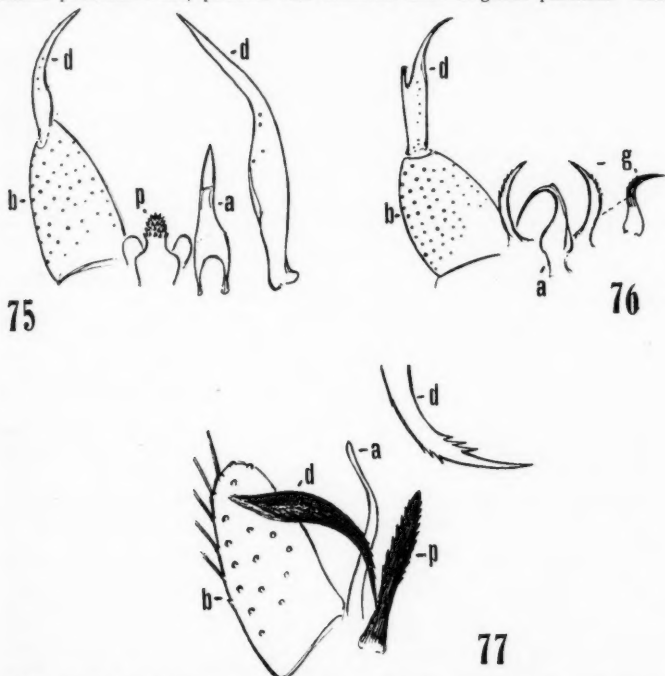
Figs. 68-74.—68. *Ormosia (Ormosia) pleuracantha* sp. nov., venation. 69-74. Male hypopygia: 69. *Ormosia (Ormosia) pleuracantha* sp. nov. 70. *O. (Ormosia) profunda* Alexander. 71. *O. (Ormosia) proxima* Alexander. 72. *O. (Ormosia) upsilon* Alexander. 73. *O. (Ormosia) unicornis* sp. nov. 74. *O. (Ormosia) subcornuta* Alexander (See fig. 1 for explanation of symbols).

Ormosia (Ormosia) unicornis sp. nov.—Belongs to the *similis* group, allied to *davisi*; thorax almost uniformly dark brown, the humeral and lateral portions of the praescutum more reddened; wings with a brownish tinge, the stigma darker; cell M_1 open by atrophy of basal section of M_3 ; male hypopygium with the outer dististyle bifid, its outer arm a strong curved black horn, the inner arm a long sinuous blackened rod that bears a strong lateral spike at near midlength.

♂. Length, about 4 mm.; wing, 4.6 mm.

Head broken. Thorax almost uniformly dark brown, the humeral and lateral portions of the praescutum more reddened. Halteres yellow. Legs with the fore and middle coxae dark brown, the posterior pair obscure yellow; trochanters yellow; remainder of legs broken. Wings with a brownish tinge, the stigma darker brown; prearcular field slightly more yellowed; veins brown, more brightened in the prearcular field. Venation: Sc_1 ending opposite or just beyond R_{5+6} , Sc_2 about opposite two-fifths the length of R_5 ; cell M_2 open by the atrophy of the basal section of M_3 ; $m-cu$ sinuous, at the fork of M ; vein 2nd A sinuous on outer third, the veins weakly convergent.

Abdominal tergites and hypopygium dark brown; basal sternites more yellowed. Male hypopygium (Fig. 73) with the tergite, $9t$, produced into a narrow spatula, the apex of which is slightly emarginate and with more than the outer half densely setuliferous. Outer dististyle, d , bifid, the outer arm a strong curved blackened horn; inner arm a long, very strongly sinuous blackened rod, very gradually narrowed to the terminal spine, on the face at near midlength bearing a further strong spike. Inner dististyle a long narrow arm, on outer margin at near two-thirds the length with an erect black spine; apical third a flattened paddlelike blade, provided with numerous small setigerous punctures. Gona-



Figs. 75-77.—Male hypopygia: 75. *Tasiocera (Dasymolophilus) miseranda* Alexander. 76. *T. (Dasymolophilus) squiresi* Alexander. 77. *T. (Dasymolophilus) subnuda* Alexander (See fig. 1 for explanation of symbols).

pophysis, g, unequally bispinuous, the inner spine long and slender, gently curved, the outer spine less than one-half as long, straight.

Holotype, ♂, Westfir, on Middle Fork of the Willamette River, 1,000 ft., August 5, 1946 (C. P. Alexander); type associated with *Ormosia subcornuta* Alexander.

The closest ally of this fly is *Ormosia (Ormosia) davisi* sp. nov., which differs in relatively slight characters of the male hypopygium. A further ally is *O. (O.) tricornis* Alexander, of the coastal redwood belt of northern California, which similarly differs in hypopygial characters.

Ormosia (Ormosia) upsilon Alexander, 1946.—Coast: Gales Creek, Wilson River, September 5, 1948 (F). Willamette Valley: Peavine: Sta. 3, September 24, October 11, 1945 (F); types.

Male hypopygium (Fig. 72) with the tergite, 9t, conspicuously emarginate to form two apical lobes, their apices with abundant roughened setae. Outer dististyle, d, a flattened scooplike blade, its outer surface with microscopic roughenings. Inner dististyle larger, broadest at midlength, where the inner margin is produced into a reflexed blackened spine, the apex of the style beyond this point strongly narrowed. Phallosome, p, consisting of a large lyriform central plate, each lateral arm bispinuous; lateral gonapophyses consisting of slender blackened hooks.

Tasiocera (Dasymolophilus) miseranda Alexander, 1950.—Coast: High Heaven, May 4, 1947 (F); Sourgrass Creek, Gualdo Falls, May 17, 1948; Tierra del Mar, May 13, 1949 (F); type material. Male hypopygium (Fig. 75); the allied more southern *Tasiocera (Dasymolophilus) subnuda* (Alexander) is shown for comparison (Fig. 77).

Tasiocera (Dasymolophilus) squiresi Alexander, 1948.—Willamette Valley: Peavine, Sta. 1, April 15, 1946 (F), types; May 1, 1947; Sta. 2, May 26, 1948, May 17, 1949; Sta. 3, May 16, 1946, April 30, May 3-14, 1947, May 11-25, 1948; Sta. 3A, May 15-22, 1946, May 12-19, 1947 (F). Male hypopygium (Fig. 76).

Molophilus (Molophilus) colonus Bergroth, 1888 (*comatus* Doane, 1900).—Coast: Saddle Mt. (Boyer), April 27, 1935 (*Macnab*). Willamette Valley: Peavine, Sta. 3A, October 3, 1945, September 9, 1948 (F). McMinnville, May 30, 1949 (F); Silver Creek Falls, May 9, 1948 (F). Southern Oregon: Malone Spring Forest Camp, August 8, 1948 (A). Cascades: Mount Hood-Hood River, October 1 (Cole). Tumalo Creek, Bend, 3,610 ft., August 15, 1948 (A); Metolius River, August 3, 1948 (A & F). Crater Lake-Pole Creek Meadows, 5,900 ft., August 7, 1948 (A). Wallows: Enterprize, 4,200 ft., June 19, 1948 (A).

Molophilus (Molophilus) falcatus Bergroth, 1888.—Willamette Valley: Silver Creek Falls, July 8, 1949 (F). Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947, August 8, 1948 (A & F); North Fork of Iron Creek, July 30, 1948 (F); Still Creek, 3,600 ft., July 17, 1947 (A & F); Stream below timberline, 5,000 ft., July 16, 1947 (A). Metolius River, 2,600 ft., June 14, 1945 (F); North Santiam, May 30, 1949 (F). Wallows: Wallowa Creek, 4,675 ft., June 29, 1948 (A).

Molophilus (Molophilus) harrisoni Alexander, 1945.—Eastern Oregon: Malheur National Forest, Seneca, June 12, 1947 (F). Blue Mts.: Lime, Burnt River, 2,400 ft., June 24, 1948 (A); Pendleton, Umatilla River, 1,070 ft., July 5, 1948 (A); Rieth, Umatilla River, July 5, 1948 (A); Upper Walla Walla River, above Milton, 1,275 ft., July 4, 1948 (A); Whitney, June 19, 1949 (Baker). Wallows: Johnson Park, Wallowa River, 2,750 ft., August 18, 1948 (A).

Molophilus (Molophilus) kulshanicus Alexander, 1949.—Cascades: Mount Hood-Hood River Meadows, 4,480 ft., July 17, 1947 (A), part of type material; Tilly Jane Creek, 5,700 ft., July 30, 1948 (A).

Molophilus (Molophilus) neofalcatus nom. nov. for *suffalcatus* Alexander, Can. Ent., 78: 159; 1946; nec *subfalcatus* Alexander, Rev. de Entomologia, 11: 906-907; 1940).

Coast: High Heaven, May 4, 1947 (F). Willamette Valley: Peavine, no station, May 3-16, 1945, swept from sword fern (F), types; Sta. 2, April 26, 1947; Sta. 3, April 13, 1949; Sta. 3A, April 17, May 21, 1946, April 25, May 5-19, 1947, April 27, June 2, 1948, May 6, 1949 (F). Happy Valley, McMinnville, April 14, 1946 (F). Cascades: Mount Hood-Sahale Falls, 4,575 ft., July 17, 1947 (A); Still Creek, 3,600 ft., July 17, 1947 (F). Metolius River, June 14, 1945 (F), part of type material.

Molophilus (Molophilus) nitidulus Alexander, 1944.—Eastern Oregon: Ochoco Mountains, June 14, 1947 (*Albight*). Wallows: Johnson Park, Wallowa River, 2,750 ft., July 2, 1948 (A).

Molophilus (Molophilus) nitidus Coquillett, 1905.—Coast: High Heaven, June 22,

1945, May 4, 1947 (F). Willamette Valley: Peavine, Sta. 1, May 11-24, June 4-20, 1946, May 22-23, 1947; Sta. 2, June 18, 1946; Sta. 3, May 15-21, June 19, 1945, May 16-29, 1946, May 3-30, 1947, June 4-16, 1948; Sta. 3A, May 23, 1947 (F). Forest Grove, May 4 (Burrill); Happy Valley, McMinnville, May 12, 1946 (F). Cascades: Mount Hood-Hood River, June 2 (Cole auct.); North Fork of Iron Creek, July 30, 1948 (F).

Molophilus (Molophilus) oregonicolus Alexander, 1946.—Willamette Valley: Peavine, Sta. 2, April 16-26, 1947 (F), abundant; Sta. 3, June 2, 1945, type; Sta. 3A, May 12, 1947 (F). Superficially, much resembling *Tasiocera (Dasymolophilus) squirei* Alexander.

Molophilus (Molophilus) paulus Bergroth, 1888.—Coast: Saddle Mountain State Park, July 24, 1949 (F). Cascades: Mount Hood-Horsethief Meadows, July 18, 1947 (F); Lost Prairie, August 3, 1948 (A).

Molophilus (Molophilus) perflavescens Alexander, 1918 (*auricomus* Alexander, 1926).—Coast: Castle Rock, June 6, 1949 (F); Coquille River, Sitkum, August 2, 1948 (H. W. Thorne); Gualdo Falls, July 14, 1949 (F); High Heaven, May 4, 1947, July 12, 1949 (F); Humbug Mountain State Park, August 11, 1948 (F); Saddle Mountain State Park, July 24, 1949 (F); Three Rivers, May 17, 1948 (F); Tierra del Mar, June 30, 1949 (F); Willamette Valley: Peavine Sta. 1, May 26, June 1, 1945, April 30, July 18, 1946, May 22, July 3, 1947; Sta. 3A, June 19, July 5, 1946, May 29, June 12-17, July 7, 1947 (F). Happy Valley, McMinnville, May 12, 1946 (F); Henderson Bridge, June 16, 1948 (F); Silver Creek Falls, August 2, 1948, July 8, 1949 (F); Willamette River, south of Dayton, June 4, 1948 (F). Southern Oregon: State Line Creek, August 9, 1948 (A & F). Cascades: Mount Hood-Bear Creek, July 16, 1947, August 1, 1948 (A & F); Beaver Creek, July 16, 1947 (F); Polally Forest Camp, August 9, 1946 (A & F); Sahale Falls, July 17, 1947, July 31, 1948 (F); Still Creek, July 16, 1947 (A & F). Big Meadows, North Santiam, August 3, 1948 (A & F); Dell Creek, July 14, 1947 (A); Hazel Creek, Dexter, July 15, 1947 (A); Metolius River, 2,600 ft., August 3, 1948 (A); North Santiam, May 30, 1949 (F); Salt Creek Falls, July 14, 1947, August 7, 1948 (A & F); Tumalo Creek, Bend, August 15, 1948 (A). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (A), June 15, 1949 (Baker); Little Phillips Creek, 2,850 ft., July 3, 1948 (A); North Powder River, 3,800 ft., June 27, 1948 (A); South Fork of Upper Walla Walla River, 1,450 ft., July 4, 1948 (A); Whitney, June 19, 1949 (Baker). I now consider *Molophilus auricomus* Alexander, of the southeastern United States, as being synonymous with the present fly. This type of discontinuity of distribution is found in other animals, such as the roach, *Cryptocercus punctulatus* Scudder.

Molophilus (Molophilus) rainierensis Alexander, 1943.—Willamette Valley: Peavine, no station, September 24, October 10, 1945; Sta. 3A, August 20, September 17, October 12, 1946, September 9, 1948 (F). Silver Creek Falls, 800 ft., August 2, 1948 (A & F). Cascades: Mount Hood-Bear Springs, 3,200 ft., August 8, 1946 (A); Hood River Meadows, 4,500 ft., July 17, 1947 (A & F). Big Meadows, North Santiam, August 3, 1948 (A & F); Metolius River, 2,600 ft., August 3, 1948 (A & F). Crater Lake-Pole Creek Meadows, 5,900 ft., August 3, 1946, August 7, 1948 (A).

Molophilus (Molophilus) rostriferus Alexander, 1943.—Southern Oregon: Ashland-Lake of the Woods, June 10, 1945 (F). Eastern Oregon: Bly, 4,355 ft., June 13, 1945 (F); Fremont National Forest, June 12, 1945 (F); Malheur National Forest, June 12, 1945 (F). Blue Mts.: Anthony Lakes, 7,000 ft., June 12, 1939 (*Lane & Lanchester*); Mottet Ranger Station, June 29, 1939 (*Lanchester*); Langdon Lake, 4,970 ft., July 3-4, 1948 (A), June 8, 1949 (*Baker & Lane*); exceedingly abundant on marsh vegetation near lake margin.

Molophilus (Molophilus) sackenianus Alexander, 1926 (*disilobatus* Alexander, 1945).—Coast: Boyer, May 9, 1949 (F); Gualdo Falls, May 17, 1948, May 13, 1949 (F); High Heaven, May 4, 1947, July 12, 1949 (F); Saddle Mountain State Park, July 24, 1949 (F). Willamette Valley: Peavine, no station, September 10, 1946; Sta. 1, May 27, 1947; Sta. 2, April 26, 1947; Sta. 3, May 14, 1947; Sta. 3A, June 19, 1946, June 2, August 30, 1948 (F); Dayton, April 20, 1947 (F); Silver Creek Falls, May 9, August 2, 1948 (A & F), July 8, 1949 (F); Willamette River, near Dayton, April 24, 1949 (F). Cascades: Mount Hood-Horsetail Falls, August 9, 1946 (A & F). Indian Ford, 3,240 ft., August 5, 1948 (F); House Rock Forest Camp, August 3, 1948 (A).

Molophilus (Molophilus) spiculatus Alexander, 1918.—Coast: Coquille River, Sitkum, August 4, 1948 (*H. W. Thorne*); Humbug Mountain State Park, August 11, 1948 (*F*). Willamette Valley: Peavine, Sta. 1, April 23, May 2, June 20, 1946; Sta. 2, June 15-27, 1946; Sta. 3, May 24, 1947; Sta. 3A, June 19, July 5, 1946 (*F*). McMinnville, in skunk cabbage association, May 13, 1945 (*F*); Muddy Valley, McMinnville, May 22, 1945 (*F*). Cascades: Mount Hood-Horsethief Meadows, 3,400 ft., July 18, 1947 (*F*); Still Creek, 3,600 ft., July 17, 1947 (*A & F*). Metolius River, August 3, 1948 (*A*); Salt Creek Falls, 3,800 ft., August 7, 1948 (*A & F*); Tombstone Meadows, South Santiam, August 17, 1947 (*Albright*). Blue Mts.: Spring Creek, 3,900 ft., June 24-26, 1948 (*A & Baker*). Wallawas: Aneroid Lake Trail, 7,000 ft., July 26, 1949 (*Baker*); Hurricane Creek, 5,460 ft., July 11, 1949 (*Sperry*); Lostine, 3,375 ft., July 2, 1948 (*A*); Wallowa Creek, 4,410 ft., June 28, 1948 (*A*).

The Butterflies of Emmet and Cheboygan Counties, Michigan, with Other Notes on Northern Michigan Butterflies¹

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In March, 1915, Paul S. Welch published a list² of Lepidoptera taken in the Douglas Lake region during the early years of the University of Michigan Biological Station. This list contained the first published enumeration of these insects from Emmet and Cheboygan Counties, although no note was made concerning specific county records. Twenty-five species of butterflies were included.³

Sherman Moore has subsequently published two lists which include records from these counties, which share the northern tip of the Lower Peninsula of Michigan. In *A List of Northern Michigan Lepidoptera* (1922), 17 of the butterflies recorded he had taken in Emmet or Cheboygan County or both. Eleven of these had not been in Welch's list. Another 11 species were added to the regional fauna in *A List of the Butterflies of Michigan* (1939), in which Moore brought together all previously published records and the results of his own examination of a number of collections. Thus the total for the two counties reached 47 species. The present list adds 27 species, bringing the grand total to 74 species of butterflies now known from Emmet and/or Cheboygan County. Several of these are represented by more than one named subspecies (race) or form.

Sixteen of the Cheboygan County records given by Moore in 1939 were apparently⁴ taken from Welch's list without additional confirming records from any other source. Unfortunately, the 1915 list was never intended to be a county list, for the "Douglas Lake Region," then as now, was taken by Biological Station workers to include neighboring Emmet County as well as Cheboygan County. No mention whatever was made of any county in that list, and Dr. Welch has informed me that no effort had been made to restrict his list to Cheboygan County. Of these 16 species, my own field work has confirmed the Emmet County occurrence of all, and the Cheboygan County occurrence of all but *Polygonia interrogationis*, of which there are three Cheboygan County specimens in the University of Michigan Museum of Zoology. So they all may now be properly admitted to the faunal list for both counties.

Moore's 1939 list reported 26 species for Emmet County and 37 for

¹ Contribution from the Biological Station of the University of Michigan.

² See complete references at end of this paper for this and other publications of which mention is made.

³ This figure does not include "*Limenitis ursula*" (= *L. astyanax*) which is here considered a subspecies of *L. arthemis* (which Welch also reported). *L. astyanax* is hereinafter omitted in the various enumerations.

⁴ Because of their appearing with county name only, and no dates.

Cheboygan County,⁵ the latter figure including the 16 species apparently taken solely from Welch's list (but not including *Limnitis astyanax*). In the present list, I add 40 species to the Emmet County total, and 30 to the Cheboygan County total.⁶ Thus the lists now stand as follows:

Known from Emmet County: 66 species.

Known from Cheboygan County: 67 species.

Known from one or both of these counties: 74 species. Of the 74 species listed, I have had field experience in at least one of the two counties with all but one, *Euchloë olympia*, which I have taken only in neighboring Presque Isle County.

The earliest and latest dates on which each species has been observed in each county are given after the name of the county. My own records, in roman type, are preceded or followed by any earlier or later dates known to Moore (1939 paper or later correspondence) in parentheses, or from University of Michigan Museum of Zoology specimens, in italics. If no date appears in roman type, then the only records known at present are from Moore or from the Museum. Thus this list becomes for these two counties—the "Douglas Lake region"—a catalog in which the original data presented are supplemented by any additional information available as may add either to the county lists or to extension of flight periods in the counties. I have examined carefully not only the arranged collection of the Museum of Zoology, but also the unworked and undistributed material (including the W. W. Newcomb collection) in search of Emmet and Cheboygan County records.⁷

Except for a few partly cloudy hours on September 30, 1950, in Emmet County, and two week ends in May, 1951, it has not been possible to collect after the first few days of September nor before the first few days of June. Therefore, a thorough picture of fall and spring occurrences cannot be presented at this time.

As the two counties are so closely similar, for all practical purposes records from one may be expected to parallel the situation in the other, although in many cases actual observations in both counties may not have been of the same extent. The only plant association of Cheboygan County which is not developed in Emmet County is that of the Jack Pines. For the record, careful attention has been paid to keep intact the integrity of data from each county, even when considerable collecting has been done along the roadsides of U. S. highway 31, which follows the county line for several miles south of Mackinaw City.

Ornithologists accept sight records made by reliable observers, and it would seem logical that lepidopterists do likewise. Especially for the records

⁵ The map in Moore's paper indicates 22 and 36 species, respectively, for these counties, but those figures are in both cases smaller than the number of species for which Emmet and Cheboygan County records are actually given in his text.

⁶ The figure of 30 includes the slightly uncertain record of *Lycaena thoë* (cf. species no. 39).

⁷ There is a source of error inherent in accepting "Cheboygan County" records not made by collectors with an eye to distributional accuracy, as specimens taken by students in the entomology classes at the Biological Station often receive Cheboygan County labels regardless of their origin. For this reason, I have tried in this report to give as full data as possible on museum specimens for which more than simply the county locality is known.

from counties other than Emmet and Cheboygan and for some earlier and later dates for species in these counties, personal sight records have been admitted when there is no doubt whatever as to their accuracy.

After the discussion of each species there follow whatever other county records I may have for the northern part of the state (i.e., the eastern part of the Upper Peninsula and north of the Bay—Oceana County region of the Lower Peninsula). These are given whether or not they duplicate previously published reports simply for whatever value they may have as recent records made within the past ten (usually the past five) years.

The comments on flower preferences or other habits are generally based on my observations made anywhere in northern Michigan, primarily Emmet and Cheboygan counties. Plants are designated by common names; an alphabetical list of these with their scientific names appears at the close of this report.

The order and nomenclature of this list follow Klots' recent and indispensable *Field Guide to the Butterflies*, except that subspecific names are often omitted—especially when northern Michigan material would seem to fall under them more because of geography than appearance. Other scientific names mentioned in parentheses are not given in the sense of supplying a synonymy, but merely for recognition of other widely-known names when a recent change to a very different name has been made. The common names are generally ones which, of those in common use, I have felt to be most descriptive without, in most cases, being simply a repetition or translation of the scientific name.

The original data of this report are based on the 1944-1951 seasons, with a few notes on prior years. Further collecting will undoubtedly add additional knowledge of flight periods, as well as some new species to the total list, but it seems advisable to assemble the information available to date.

ACKNOWLEDGEMENTS

In the process of assuring correct determinations for my material, I have become indebted to several specialists, to whom I am thankful for checking some of the more troublesome specimens. Mr. C. F. dos Passos has kindly examined several of the Satyridae; Mr. H. K. Clench, several Theclinae (including the *Incisalia*), and Dr. A. B. Klots, the *Colias*. Dr. Wm. T. M. Forbes determined the *Erynnis lucilius*. To Dr. A. W. Lindsey, of Denison University, I am grateful not only for examining all the Hesperidae, but also for his early and continued encouragement of my work with the Lepidoptera.

A deeply-appreciated grant from the Denison University Research Foundation supported the studies during the summer of 1950, when many valuable additions were made to my notes as a result of greatly increased field work. Dr. H. B. Hungerford, of the Department of Entomology of the University of Kansas and the University of Michigan Biological Station, Dr. Paul S. Welch, of the Department of Zoology of the University of Michigan and the Biological Station (retired 1951), and Dr. T. H. Hubbell, Curator of Insects in the University of Michigan Museum of Zoology, have rendered many courtesies in the preparation of this report. Mr. Sherman Moore, of Detroit, has been very helpful in correspondence.

BUTTERFLY HABITATS AND HABITS IN THE DOUGLAS LAKE REGION

Every collector has his favorite collecting spots; probably in many cases they are such simply because they happened to be the first places where he had good fortune in his captures in a given region and as a result repeated

his visits to the exclusion of other places which might have been just as productive. At any rate, for the benefit of collectors who may be in the Douglas Lake region, it might be useful to describe briefly a few areas which have proved particularly good for collecting. In the case of the less common species, exact localities are often given in the discussions under the list of species.

One of the best places for general collecting has been at a crossroads two miles south of Riggsville (about three miles east of the University of Michigan Biological Station). A variety of habitats—wet pastures, woods, and dry, weedy roadsides—occur in the four corners here, and the productivity of the spot is further attested by good collecting in other orders of insects in addition to the Lepidoptera.

Farther north in Cheboygan County, a dirt road along the eastern edge of section 31, Mackinaw Township, has provided some good collecting. Recent grading, however, has destroyed the many shallow mud puddles which were attractive to a large number of butterflies (both in species and individuals); but the damp, weedy roadsides persist. Along this road, known locally as the "Stimpson Road," have been seen over a third of the species listed herein for Cheboygan County.

South of the Mackinaw City limits, the center stripe⁸ of U. S. highway 31 follows the line between Emmet and Cheboygan counties for about five and a half miles. For the first mile or two south of town, at least, the roadsides are good for Hesperidae, especially if one includes the Mackinaw City golf course (which has not functioned for many years). The golf course is on the Cheboygan County side of the road (section 19, Mackinaw Township), and overlooks the old Nipissing lake bluff. It is overgrown with weeds as well as grasses, and attracts many butterflies.

The southern part of Cheboygan County is of particular interest, for it marks the northern edge of the Jack Pine plains of the Lower Peninsula of Michigan. Butterfly collecting in this region has been confined to one area south of Indian River, in the northeast quarter of Mentor Township. Here (mostly in sections 3 and 10), are not only the typical pine plains (characterized by Jack Pine and Red, Black, and hybrid Oaks, with a shrubby undergrowth of Sweet-Fern and several ericaceous species) but also a fairly open prairie-like meadow spotted with Shrubby Cinquefoil, and an even damper area of Cat-tails, Swamp Milkweed, Sweet Flag, and Wild Blue Iris. The latter area is at the western border of the Jack Pine region; deciduous woods (including much aspen) lie beyond it. A great variety of plants, some of which (like Butterfly-weed and Blazing-star) are found uncultivated nowhere else in the region, are attractive to butterflies in this Jack Pine area, and several collecting trips there in 1950 and 1951 produced many records of interest.

These special areas—crossroads south of Riggsville, Stimpson Road, Mackinaw City golf course and U. S. 31, and the Jack Pines—are referred to in the pages which follow without further explanation.

Collecting has been conducted in Emmet County extensively around

⁸ Of this precise bit of information I am assured in a letter from the Michigan State Highway Department, April 7, 1948.

Mackinaw City, and in many scattered places all the way to the southern edge of the county. Interesting specimens have been taken from time to time, but no one spot—unless it be the marshy roadsides of Cecil Bay (west of Mackinaw City)—has proved to be remarkably productive. This may be merely because, except for the roadsides and fields near Mackinaw City, no spots have been visited with as much regularity or frequency as certain portions of Cheboygan County. The city dump of Mackinaw City has been a good source for common material, for there is a great variety of weeds and some other plants from lawn and garden refuse in the dump.

The butterflies which occur in company with one another are sometimes of interest. In June of 1946 the three Crescents—*Phyciodes tharos* and *P. batesii* and *Melitaea nycteis*—were extraordinarily abundant along the roadsides of the region. At mud puddles and dead frogs in the Stimpson Road, dozens of these butterflies were gathered, with a mixture of three other species most conspicuously freely associating with them: *Erynnis icelus*, *Feniseca tarquinius*, and *Plebeius saepiolus*. Clusters of insects were common every few yards along a mile of road. Some groups were predominantly *M. nycteis*, others predominantly *P. tharos* and *batesii*. Some were about equally mixed, and included the other three butterflies. Once, a group of two or three dozen *P. saepiolus* alone was observed at a mud puddle. *Feniseca*, in addition to associating with the other species, often occurred singly in the road; but whether singly or with others could be detected at some distance by the general angle of its body. *Feniseca* would come to rest with the head pointing downward and the abdomen upward, while the small *Phyciodes* held the body horizontally (reminding one of the familiar distinction between *Anopheles* and *Culex*). Not wary at all, *Feniseca* could easily be captured directly with a cyanide jar, without resort to the use of a net. *Phyciodes* and *Feniseca* were active along the Stimpson Road as late as 4 p.m., when practically all other butterflies were no longer in evidence. On cloudy days, particularly, *P. tharos* often feigned death upon being captured.

Along this same road in late August and early September of 1944, *Polygonia progne* and *Limenitis arthemis* (including form *proserpina*) were unusually abundant. Damp spots were preferred, but manure and dead frogs were also visited. Several other species occurred with these two, but in about the same abundance as other years.

All the species of *Speyeria* and *Boloria* of the region were very common at the crossroads south of Riggsville in 1950. The larval food plants (Violets) were abundant in the adjacent pastures, and the adults of all species visited flowers along the roadside. *Cercyonis pegala nephele*, *Walengrenia otho egeremet*, and *Atrytone ruricola* were also somewhat common at this place, but the skippers generally avoided the company of the nymphalids. *Polites peckius*, on the other hand, often visited the same blossoms as the fritillaries.

Along the roadsides south of Mackinaw City and on the golf course, the small skippers mix freely, and were observed especially in 1945 and 1946, flying over grasses and stopping at damp spots in the ditches. *Thorybes pylades*, *Erynnis icelus*, *Hesperia sassacus*, *Polites themistocles*, *P. mystic*, and *Poanes hobomok* are the commonest in middle and late June, but *Cartero-*

cephalus palaemon and *Amblyscirtes vialis* occasionally occur. Later in the summer (at least in 1950 and 1951), *Hesperia laurentina* appears in some numbers on the golf course, the solitary representative of its family two months after the other species mentioned normally reach their peak.

Whether climatic conditions, biological causes of population fluctuations, or acuteness and extent of the collector's observations would best explain the changes from year to year in the apparent numbers of some species would be hard to say. Probably all play a part. While most species remain fairly constant from year to year, some may appear in quantity one season, to be almost completely absent for others. In 1944, it was *Polygonia progne*; in 1945 and 1946, *Melitaea nycteis*; in 1950, *Pieris napi* and *Boloria toddi*; in 1950 and 1951, *Colias interior*, which showed the most striking increases in abundance, being almost unknown in other years. About ten years ago, *Precis lavinia coenia* was common, but it has scarcely been seen since. Albino ♀♀ of *Colias* have been very uncommon ever since the late summer of 1943, when they occurred in considerable number. Many other examples, less spectacular, could be cited as evidence of the fact that the collector never finds two seasons the same. There is no reason why species considered scarce in this report—at least some of them—may not become common at some time in the future.

If it were possible to make regular field notes each year, covering as closely as possible the same areas at the same time, some less subjective basis for discussion of numbers than chance observation would be had. This thoroughness of observation has not, unfortunately, been possible.

LIST OF SPECIES

Family SATYRIDAE—The Satyrs and Wood Nymphs

1. *Lethe portlandia anthedon* Clark, Pearly Eye.—Emmett: July 2-August 25. Cheboygan: (July 4) July 7-August 4. Never a really common species, but a few specimens can generally be found each year locally in open woods, along wooded and shaded roadsides, or occasionally in meadows. About 4:30 p.m. on the sunny afternoon of July 7, 1945, several of these butterflies were flying in the partial shade of Red Pine in Wilderness State Park (Emmett Co.), where they would alight on the trunks of the trees, head downward. When disturbed, they would flit to the ground, where they were easily taken.

2. *Lethe eurydice* Joh., Eyed Brown.—Emmett: July 3-July 26. Cheboygan: July 7-July 27. Common in low, weak flight over grasses, especially in wetter places; also occurs in sphagnum bogs. Specimens vary greatly in the depth of ground color on the wings, ranging from a dark brown to a very light brown with areas of white around the ocelli.

3. *Euptychia cymela* Cram. (*Megisto eurytus* Fabr.), Little Wood Satyr.—Emmett: June 14-July 4. Cheboygan: June 19. July 1-July 7. Especially common in 1945. The butterfly is fond of wooded places, and is seldom found far from them. It will fly even on cloudy, drizzly days, and although it will sun itself on leaves on clear days does not seem attracted to flowers.

Other county records: Oceana, June 27.

4. *Coenonympha tullia inornata* Edw., Inornate Ringlet.—Emmett: July 8. One ♂ taken in 1947, flying low over the marshy ground along Cecil Bay at the mouth of French Farm Creek. The following year, in Mackinac County, several of these butterflies were flying low and jerkily in a grassy field between the woods and the highway south of the St. Ignace business district. They would light low down in the grasses, where they were taken without difficulty.

Other county records: Mackinac, July 2.

5. *Cercyonis pegala nephele* Kby., Common Wood Nymph.—Emmett: July 25.

September 1. Cheboygan: July 9-August 29. A very common species in the region, being especially abundant along wooded roadsides and in open glades in woods. It sometimes flies on cloudy days. The ocelli of the upper surface are reduced in practically all specimens, and are occasionally completely lacking on the secondaries of the ♂♂. Boneset and Canada Thistles are particularly attractive to this butterfly, which has also been noted on Alfalfa, Joe-Pye Weed, White Sweet Clover, and manure.

Other county records: Antrim, July 28; Charlevoix, July 7; Delta, July 17; Mackinac, August 9-13; Schoolcraft, July 17.

6. *Oeneis chryxus strigulosus* McD., Chryxus Arctic.—Emmet: (May 30). Cheboygan: June 21. My only specimen (a somewhat tattered ♂) was taken in 1947 on the abandoned Mackinaw City golf course, where it lit on a low leaf.

Family DANAIIDAE—The Monarchs

7. *Danaus plexippus* L., Monarch or Milkweed Butterfly.—Emmet: June 2-September 30. Cheboygan: June 24-September 5. From great abundance in 1942 and 1943, this species decreased sharply in numbers, and has for the past few years been gaining steadily again. One summer evening, a Monarch fluttered at my lighted window in Mackinaw City (Emmet Co.) for about half an hour.⁹ On August 6, 1951, at a beachpool in Hammond Bay, Presque Isle Co., I watched a ♀ struggling to escape from a Sundew plant (*Drosera linearis* Goldie). The unfortunate insect was caught by several legs and the tip of the right forewing, and did not seem to be making successful efforts to free itself.

The blossoms of Common Milkweed, the larval food plant, are favorites with this butterfly, and I have also observed it on Asters, Beach Pea, Blazing-star, Canada Thistle, Joe-Pye Weed, Shrubby Cinquefoil, and Touch-me-not. It was very common at the flowers of Lavendar Wild Bergamot on Seul Choix Point, Schoolcraft Co., on August 30, 1950.

Other county records: Arenac, October 1; Charlevoix, July 7; Delta, July 17; Grand Traverse, July 28; Leelanau, July 27-29; Mackinac, June 4-August 26; Ogemaw, October 1; Otsego, July 10; Presque Isle, August 6; Roscommon, October 1; Schoolcraft, August 30.

Family NYMPHALIDAE—The Brush-footed Butterflies

8. *Speyeria atlantis* Edw., Mountain Silverspot.—Emmet: July 1-August 17. Cheboygan: July 6-August 9. Although often associated with the following two species, both of which are rather more abundant, *S. atlantis* prefers moister situations. It is greatly attracted by Canada Thistle, and also visits Burdock, Butterfly-weed, Hedge-nettle, and Joe-Pye Weed. I have not seen it at Milkweed, but several of my specimens bear Milkweed pollinia on their tarsi. It visits manure, and several have been seen at a mud puddle.

Other county records: Luce, August 9.

9. *Speyeria cybele* Fabr., Great Spangled Fritillary.—Emmet: June 28-September 5. Cheboygan: July 9-August 9. In the revised edition of the *Butterfly Book*, W. J. Holland (1931, p. 87) described "*Argynnis cybele* subsp. *krautwurmi*," the type of which, a ♀, was collected at Les Cheneaux, Mackinac County, Michigan, on August 15, 1905 (dos Passos & Grey, 1947, p. 7). There were three paratypes, all ♀♀. W. D. Field (1938, p. 121, repeated 1940) has expressed the opinion that *krautwurmi* represents a dimorphic ♀ form of *cybele*; this view was followed by Macy and Shepard (1941, p. 96). Although a few Emmet and Cheboygan County ♀♀ are less buff than the figure of the type of *krautwurmi*, the name can still be applied to them; ♂♂ from the region appear typical, although somewhat variable, so Field's opinion is apparently sustained. The type locality for *krautwurmi* is less than 40 miles from Douglas Lake.

This is a common butterfly during the latter part of July and early August. Burdock, Canada Thistle, and Common Milkweed have proved to bear the flowers most attractive to this fritillary, but others on which it has been seen are as follows: Aster, Boneset, Butterfly-weed, Dogbane, Fireweed, Hedge-nettle, Joe-Pye Weed, Red Clover, Rough-fruited Cinquefoil, Swamp Milkweed, Swamp Thistle, and Yarrow. Rarely it will be found at damp spots in dirt roads.

⁹ Occurrence of *D. plexippus* at light was evidently first reported by Edwards (1885).

Other county records: Alger, August 8 (♀ *krautwurmi*); Antrim, July 28; Charlevoix, July 5; Mackinac, July 16.

10. *Speyeria aphrodite* Fabr., Silverspot Fritillary.—Emmett: (July) August 11–September 4. Cheboygan: July 9–August 26. A common butterfly, often occurring in company with the preceding species. Some specimens are very close in appearance to race *alcestis* Edw. Favorite flowers have been noted as Burdock, Canada Thistle, Common Milkweed, and Hedge-nettle. Others which it has been seen to visit include Blazing-star, Boneset, Butterfly-weed, Dogbane, Joe-Pye Weed, Orange Hawkweed, and Swamp Milkweed. It, too, occasionally stops at a damp puddle.

Other county records: Charlevoix, July 7; Otsego, July 10; Schoolcraft, August 30.

Sight records for individuals of *Speyeria* for which specific determinations could not be made in the field include visits to Goldenrod, Red Clover, and Ox-eye Daisy, in addition to the flowers listed above.

11. *Boloria selene* Schiff. (*Brenthis myrina* Cram.), Silver-bordered Fritillary.—Emmett: June 17–August 19. Cheboygan: (May 28) July 7–August 18. Our specimens have the dark markings if anything a little lighter than Klotz' figure of the "average" race *myrina* Cram., rather than heavier as they should be in the north for race *atrocostalis* Huard.

This is a common butterfly from June until mid-August, definitely preferring moist habitats, such as marshy margins of lakes and streams, and wet meadows. It is also one of several species which occur frequently in sphagnum bogs. Among the flowers on which it has been seen are those of Goldenrod (Flat-topped and other spp.), Hedge-nettle, Joe-Pye Weed, and Orange Hawkweed; I have observed it not only on the normal form of Canada Thistle but also—unlike other butterfly species—on the white-flowered form. Several specimens have Milkweed pollinia on their legs.

Other county records: Luce, August 9; Schoolcraft, July 18.

12. *Boloria toddi* Holl. (*Brenthis bellona* Fabr.), Meadow Fritillary.—Emmett: (May 23) May 26–July 25. Cheboygan: (May 28) July 15–August 14. After hoping for several years to find the Meadow Fritillary in the region, I was finally successful in the summer of 1950. That season, it was common at the crossroads south of Riggsville, and was also found at various other places throughout Cheboygan and Emmet counties. It was clearly fond of Canada Thistle, but also visited Joe-Pye Weed. One specimen has many Milkweed pollinia on its tarsi.

Other county records: Alger, August 8.

Euphydryas phaeton Drury, Baltimore Checker-spot.—For over eight years I have diligently searched for this butterfly or signs of its larvae in the vicinity of the food plant (Turtlehead), but always without success. I have one specimen taken in my company by Frank Buser on July 10, 1949, in Otsego County. It was captured in an extensive region of boggy ground where there was Turtlehead, a great deal of Swamp Valerian, and other wet ground plants, about five miles east of Vanderbilt, near the Sturgeon River.

13. *Melitaea nycetis* Dbldy., Silver Crescent.—Emmett: June 15–July 2. Cheboygan: June 15–July 8. Extremely abundant during the latter half of June in 1945 and 1946, this species has been seen only rarely since. It was common in great numbers at mud puddles and dead frogs; the only flower records are Coreopsis and Red-osier Dogwood.

14. *Phyciodes batesii* Reak., Tawny Crescent.—Emmett: June 11–July 17. Cheboygan: June 13–June 29. The most reliable characteristics for distinguishing this sibling species from *P. tharos* have been the under surfaces of the secondaries—frequently a clear almost immaculate yellow, and the generally much darker aspect of the wings above. *P. tharos* often has the subapical black spot of the primaries below smaller than the medial patch on the inner margin, so this characteristic is not distinctive to *batesii*. Forms appearing intermediate with *tharos* occasionally occur.

Batesii is fairly common with *tharos* at mud puddles and moisture in ruts of dirt roads, but seldom after late June. It has been seen attracted to dead frogs and to the blossoms of Ox-eye Daisy. Probably it visits more flowers, but because of the similarity to *tharos* I have been cautious in making field notes.

15. *Phyciodes tharos* Drury, Pearl Crescent.—Emmett: June 3–September 5. Cheboygan: June 9–August 29. This is one of the most abundant and widely distributed butterflies in the region throughout the season. It is particularly common in large numbers at mud puddles and damp spots in dirt roads and also has visited, in addition to dead frogs, the flowers of Common Buttercup, Coreopsis, Dogbane, Hedge-nettle, Lake

Huron Tansy, Orange Hawkweed, Red-osier Dogwood, and Swamp Milkweed. One tame individual sipped moisture from my sweaty nylon watchband.

Other county records: Arenac, June 16; Bay, September 8; Delta, July 17; Mackinac, August 13; Otsego, July 10.

16. *Polygonia interrogationis* Fabr., Question Mark.—Emmet: August 19-August 30. Cheboygan: July 17-August 10. Very scarce in the region. The records are August 19, 1944, at damp spot in road; August 30, 1948, on sandy beach of Straits of Mackinac; three specimens from Cheboygan County in the University of Michigan Museum of Zoology.

Other county records: Alger, August 8; Oceana, June 28.

17. *Polygonia comma* Harris, Hop Merchant or Comma.—Emmet: July 25. (*P. c. comma*), Cheboygan: June 26-July 15-August 10 (all *P. c. dryas*). As scarce as the preceding species. My two specimens, one from each county, were both taken in 1950—one in flight in the swampy area at the edge of the Jack Pine region, and one lit on a gravel road.

18. *Polygonia faunus* Edw., Green Comma.—Emmet: August 8. Cheboygan: May 13-August 23. I have four specimens, taken at a damp spot in a dirt road, on Canada Thistle, and on Joe-Pye Weed.

Other county records: Alger, August 8.

19. *Polygonia progne* Cram., Gray Comma.—Emmet: (May 23) July 18-August 9. Cheboygan: (May 12) June 15-September 5. Abundant in late summer along the Stimpson Road south of Mackinaw City in 1944; much less common since. Fond of puddles, manure, and dead frogs, but once taken on Aster flowers. Frequently sunning on foliage or in road. Some of our specimens are form *l-argenteum* Scud.

Other county records: Otsego, July 10.

20. *Nymphalis j-album* Bdv., Compton Tortoise.—Emmet: July 25-August 25. Cheboygan: May 13-August 16. September 9. Considerably commoner in 1951 than in previous years, as were *N. milberti* and *antiopa* also. Mostly at damp spots in roads and on beaches; occasionally found inside cars and busses with open windows, seeking to escape. There are two specimens in the University of Michigan Museum of Zoology which bear the annotation that they were collected at light; one was taken by Max Peet on August 9, 1937, and is labeled Burt Lake; the other was taken at Douglas Lake on September 9, 1934 (no collector given).¹⁰

Other county records: Alger, August 8; Mackinac, August 13-26; Otsego, July 10.

21. *Nymphalis milberti* Latr., American Tortoise Shell.—Emmet: August 3-August 24. Cheboygan: June 26. July 7-August 18. Commonest at damp spots along sunny roads and in weedy fields; recorded visiting Burdock, Joe-Pye Weed, and Shrubby Cinquefoil. More abundant in 1951.

Other county records: Alger, August 8; Otsego, August 4.

22. *Nymphalis antiopa* L., Mourning Cloak.—Emmet: (May 23) June 6-September 5. Cheboygan: May 13-September 5. Although somewhat commoner in 1951, this species does not vary greatly in numbers from year to year. Most often seen flying along roadsides and in sunny glades, but taken at puddles, on Asters, and on dead frogs. One was observed flying with a purple *Limenitis*, the two butterflies chasing each other. On August 29, 1945, there was along the Emmet County side of U. S. 31 south of Mackinaw City a dead specimen of *antiopa* in which the yellow border is wider than usual, obliterating completely the blue spots but still leaving some black next to the yellow.¹¹ Larvae of this species have been seen on American Elm, Quaking Aspen, and Willow, and were quite common in 1951.

Other county records: Arenac, June 16; Charlevoix, July 7; Leelanau, July 29; Mackinac, August 20-26; Otsego, July 10-August 4.

23. *Nymphalis californica* Bdv., California Tortoise Shell.—Emmet: September 6, 1945. A single specimen in almost perfect condition taken at moist sand on the beach

¹⁰ Scudder reported large numbers of *j-album* at a New England lighthouse (1874).

¹¹ After the lifting of gasoline rationing in August of 1945, there was a sharp increase in the number of dead butterflies along the side of the highway—additional casualties resulting, perhaps, from the increase in speed and number of cars. This aberrant Mourning Cloak was the most striking casualty found.

of the Straits of Mackinac about one mile west of the center of the town of Mackinaw City.

Evidently the only previous Michigan record¹² for this species appeared in October, 1945 (Boram, 1945). This note reports four wet specimens washed ashore on Lake Michigan two miles north of Ludington [Mason County] and discovered on September 4, 1945, by Clifford Boram, Jr. These two collections, separated by 175 miles and two days, probably represent individual vagrants or perhaps strays from a migrant flock correlated with the extensive flights of *californica* in British Columbia and Alberta that year (cf. Leech, 1945).

24. *Vanessa atalanta* L., Red Admiral.—Emmet: June 3-September 5. Cheboygan: July 22-September 5. Not a common butterfly in the region; perhaps more abundant in September. Seen flying along weedy roadsides and sometimes on Asters. A gravid ♀ was taken on June 19 as it was flying in a strong wind on a cloudy day along the wind-swept shore of the Straits of Mackinac.

Other county records: Charlevoix, July 7; Mackinac, June 30-August 20; Oceana, June 28.

25. *Vanessa cardui* L., Thistle Butterfly or Painted Lady.—Emmet: June 3-August 27. Cheboygan: late June. Very scarce, except in 1949, when it was rather common around the Biological Station and elsewhere in late June. Flower records are Bastard Toadflax, Beach Pea, Canada Thistle, Cherry, and Ox-eye Daisy.

Other county records: Mackinac, June 16-August 4.

26. *Vanessa virginienensis* Drury, Painted Beauty.—Emmet: (May 23) June 2-September 5. Cheboygan: June 28-September 5. This butterfly fluctuates in numbers from year to year, and is only rarely and locally abundant. It visits a variety of flowers, including Asters, Boneset, Burdock, Cherry (including Sand Cherry), Coreopsis, Goldenrod, Joe-Pye Weed, and Swamp Thistle. In addition, there are Milkweed pollinia on the legs of several specimens.

Other county records: Mackinac: June 4-August 26.

27. *Precis lavinia coenia* Hbn., Buckeye.—Emmet: August 21-September 1. Cheboygan: August 26. About ten years ago the Buckeye was abundant around Mackinaw City, and I reared several larvae found on Butter-and-Eggs. I have not seen a specimen at all in northern Michigan since 1944, when the above dates were recorded for specimens in flight or lit on foliage. The specimen in the Museum of Zoology was taken by W. W. Newcomb in 1932 at Wilderness State Park, and is in perfect condition.

28. *Limenitis arthemis* Drury, Banded Purple or White Admiral.—TYPICAL FORM: Emmet: June 30-August 30. Cheboygan: July 7-September 4. INTERMEDIATE FORMS (*astyanax* Fabr. & mostly "*proserpina*" Edw.): Emmet: June 24-August 29. Cheboygan: June 27-September 5. The typical form, with distinct white band, is rather common and although apparently fondest of mud puddles has been recorded on manure, a dead bird, and the blossoms of Joe-Pye Weed. It frequently suns itself on foliage. The intermediate forms are, in a word, puzzling. Some specimens taken in late June and early July, 1951, in Cheboygan and Charlevoix counties are evidently race *astyanax*. A very few specimens in the Museum of Zoology and taken in Cheboygan County are evidently also *astyanax*. Most intermediate forms (which with some misgivings I lump under "*proserpina*") have at least a trace of a white band beneath if not above (one specimen, at least, has it completely across the primaries above) or, if they lack any trace of the band, also lack the greenish suffusion of true *astyanax*. These intermediate forms are generally even commoner than typical *arthemis* and usually occur with it. They are also most common at damp spots in dirt roads and sunning, but have been noted on dead fish, dead frogs, manure, a dead bird, and the flowers of Asters and Joe-Pye Weed.

Other county records: Charlevoix, July 5 (*astyanax*).

29. *Limenitis archippus* Cram., Viceroy.—Emmet: June 29-September 5. Cheboygan: June 23-September 4. Quite regular in numbers from year to year, and common. Noted on Aster, Boneset, Burdock, Canada Thistle, Joe-Pye Weed, Ninebark, and manure.

Other county records: Arenac, September 7; Mackinac, August 13; Schoolcraft, July 18.

¹² The present record was briefly mentioned in Lep. News (Voss, 1950).

Family LYCAENIDAE—The Hairstreaks, Coppers, and Blues

30. *Strymon titus* Fabr., Coral Hairstreak.—Emmet: July 25-August 1. Cheboygan: August 4-August 18. By far the commonest *Strymon* in the region. Most ♀♀ and many ♂♂ have a red spot on the upper surface at the anal angle of the secondaries. Common in the meadow in the Jack Pine plains on Lavendar Wild Bergamot and Shrubby Cinquefoil flowers; also on many other flowers there and elsewhere: Blazing-star, Butterfly-weed, Common Milkweed, Goldenrod (including Blue-stem and Flat-topped Goldenrods), and Swamp Milkweed. Taken once on manure. Characteristic of dry roadsides and fields.

31. *Strymon acadica* Edw., Acadian Hairstreak.—Emmet: July 23-August 8. Cheboygan: July 22-August 14. Quite local and seldom abundant, being commonest early in August. Most often taken on foliage, although it has been seen to visit Common Milkweed and Joe-Pye Weed.

32. *Strymon falacer* Godt., Banded Hairstreak.—Cheboygan: July 15-July 22. Not found in the region until 1950, when I took one specimen on July 15 in the vicinity of Oak in the Jack Pine plains—further collecting may prove it to be more common there. I have also a specimen taken on Common Milkweed by Marie Peterjohn at the Biological Station on July 22, 1950, and one taken July 15, 1951, by Elizabeth Poe.

33. *Strymon liparops strigosa* Harris, Striped Hairstreak.—Emmet: August 25, 1950. Cheboygan: July 9, 1951. Evidently very rare. The Emmet County record is based on one specimen I took on Boneset along a dirt road in wet ground in the center of section 25, Wawatam Township. The Cheboygan County specimen was taken by Richard Baranowski in a meadow by Burt Lake.

34. *Incisalia augustinus* Westw., Brown Elfin.—Emmet: May 13-June 23. Cheboygan: May 5-May 14 (May 26). Rather common during the first half of May, 1951 (the only season thus far when May collecting has been conducted). Evidently a widely distributed species, occurring in a variety of habitats. It was common in two sphagnum bogs visited (Mud Lake Bog, sections 7 & 18, Inverness Tp., Cheboygan Co., and Galloway Bog, sections 27 & 34, Carp Lake Tp., Emmet Co.). Several fresh butterflies were in an open, dry, young aspen and pine woods east of Cheboygan (near Elliott's Creek) on May 5, and there were a large number of individuals, many of them becoming ragged, in the Jack Pine plains on May 14. In all of these places, Blueberry (the larval food plant) was abundant. There were large numbers of *augustinus* and *polios* on May 14 in Presque Isle County in an open, sandy woods near Lake Huron (N ½ Krakow Tp.) where there were Blueberry and Bearberry; both species were gathered at a damp spot in a dirt road and were flying over it. Occasionally in Mud Lake Bog, *augustinus* visited Blueberry blossoms.

The June 23 specimen was taken in 1947 near the mouth of French Fork Creek, in Cecil Bay. In the Museum of Zoology there is a specimen taken by W. C. Stinson at Cecil Bay on May 23, 1932.

Other county records: Presque Isle, May 14.

35. *Incisalia polios* Cook & Wats., Hoary Elfin.—Emmet: May 23. Cheboygan: May 14. Very common in the Jack Pine plains on May 14, 1951, in company with *I. augustinus* and *niphon*. It was also abundant with *augustinus* in Presque Isle Co. (see under *augustinus*, above). The species appeared to have just passed its peak, for there were not so many ragged specimens as there were of *augustinus*. The butterflies were flying low over grasses and low shrubs and all three species evidently were visiting the blossoms of Blueberry as well as stopping on a small dry dirt road and on foliage.

There are 3 ♀♀ and 2 ♂♂ in the Museum of Zoology, taken by W. W. Newcomb at Cecil Bay on May 23, 1932.

Other county records: Presque Isle, May 14.

36. *Incisalia niphon* Hbn., Banded or Pine Elfin.—Cheboygan: May 14-May 29. Very common in the Jack Pine plains on May 14, 1951, along with *I. augustinus* and *polios* (q. v.). Presumably Jack Pine, Blueberry, and Bearberry—all abundant in that area—served as the larval food plants for the three species, respectively. The *niphon*, almost without exception, were in perfect condition and were evidently at their peak.

In the Museum of Zoology there are two specimens taken near the Biological Station by I. J. Cantrall on May 29, 1939—a ♂ collected at Sedge Point (NE part of Douglas Lake) and a ♀ from the aspen-birch-maple woods just southeast of the Station.

(There are, incidentally, scattered Jack Pines in these woods, as well as White and Red Pines.)

37. *Feniseca tarquinius* Fabr., The Wanderer.—Emmet: (May 23) July 1-August 29. Cheboygan: June 15-August 13. Less common in the past three or four years. Never seen to visit flowers, but always taken at damp spots and in dirt roads. Found only along roads in wet places where Alder grows. Some of our material resembles race *nova-scotiae* McD.

Other county records: Mackinac; August 13.

38. *Lycæna phlaeas americana* Harris (*L. hypophlaeas* Bdv.), American Copper.—Emmet: June 3-September 30. Cheboygan: (April 22) June 15-September 5. A common species, especially in old fields and similar places in the vicinity of Sheep Sorrel. The butterfly has a reputation for pugnacity; I observed it once chasing *Colias philodice*. It has been observed at Asters, Cherry, Clover, Daisy Fleabane, Goldenrod (including Canada Goldenrod), Meadowsweet, Orange Hawkweed, and White Sweet Clover, the last named seeming to be particularly attractive. It was once seen at a damp puddle.

39. *Lycæna thoë* Guer., Bronze Copper.—Emmet: June 22, 1945. Cheboygan: July 5, 1925 (?—see below). My only specimen, a ♀, was flying very lazily, and lit low down in grasses near a water-filled ditch along highway M 108 just north of the Mackinaw City limits. There is a ♂ in the collection of the University of Michigan Biological Station, labeled simply "Douglas Lake, Mich., 7-5-1925, Charles Martin"; the chances are high that this was collected in Cheboygan County, but the same problem is involved as mentioned in footnote 7. At any rate, *thoë* may be considered a very rare species in the region.

40. *Lycæna epixanthe michiganensis* Rawson, Bog Copper.—Emmet: July 11-July 18. Cheboygan: June 29-July 27. Common in sphagnum bogs, where the larvae must feed on the Small Cranberry, as the Large Cranberry is of very limited occurrence in the Douglas Lake region. The peak of abundance is during the first half of July. The butterflies light frequently on low shrubs, and are easily taken.

41. *Lycæna helloides* Bdv., Purplish Copper.—Cheboygan: June 28-August 22 (August 24). Thus far, found to be very scarce. My two specimens, both ♀♀, were taken as they flew over low ground: June 28, 1950, by Nichols' Bog 13 (section 2, Burt Tp.); August 22, 1945, by Devereaux Lake (section 29, Aloha Tp.).

42. *Lycæna dorcas* Kby., Dorcas Copper.—Emmet: August 31, 1950. Also a rare copper, at least south of the Straits of Mackinac. The single specimen reported above was a ♀, taken on the blossoms of Shrubby Cinquefoil on Waugoshance Point, Wilderness State Park. The species seems to be more common in Mackinac County, where a few specimens have been taken and others seen along the dirt road which follows the shore of the Straits from St. Ignace toward Gros Cap.

Other county records: Mackinac, August 13-30.

43. *Everes comyntas* Godt., Tailed Blue.—Emmet: August 2-September 5. Cheboygan: July 1-September 5. Rather common in late summer, and more often seen at puddles and damp spots than on flowers.

Other county records: Mackinac, August 13.

44. *Plebeius saepiolus* Bdv., Greenish Blue.—Emmet: June 13-June 21. Cheboygan: (June 8) June 15-June 23. Abundant in 1946 in crowds at mud puddles, especially along the Stimpson Road south of Mackinaw City. Seen only rarely since. Also recorded visiting Orange Hawkweed.

45. *Glaucopsyche lygdamus* Dbldy., Silvery Blue.—Cheboygan: May 13. A number of specimens were seen (and several taken) in 1951, along with *L. argiolus pseudargiolus*, by the side of a dirt road and in the neighboring open woods just south of Mud Lake Bog. Also seen in the bog.

46. *Lycænopis argiolus pseudargiolus* Bdv. & Lec., Common Blue or Spring Azure.—Emmet: May 5-July 25. Cheboygan: May 5-July 26. Abundant in spring and on into early summer. Noted in May on Leatherleaf, Serviceberry, and Squirrel Corn blossoms.

Other county records: Mackinac, June 21.

13 Not a good sphagnum bog at present, but functioning as a farm pond in an open pasture.

Family PAPILIONIDAE—The Swallowtails

47. *Papilio polyxenes asterius* Stoll. (*P. ajax* of many recent authors), Black Swallowtail.—Emmet: August 22. Cheboygan: July 15 (?)–August 19. Evidently a scarce butterfly in the region, for it is too conspicuous to be overlooked easily. I took one ♂ on August 22, 1944, as it flew along a street in Mackinaw City, only a couple of blocks from the Cheboygan County line. On August 19, 1948, I saw several individuals at moist mud along the edge of the Black River, near Alverno (Cheboygan Co.); they were active until as late as 6:00 in the evening, but without a net it was impossible to capture any. There is a ♀ labeled "Cheboygan Co., vii 15, 1945, Ethel Lucovic," in the collection of the University of Michigan Biological Station. A ♂ marked simply "Douglas Lake, Cheboygan Co., 1943" is in the Museum of Zoology in Ann Arbor.

Other county records: Bay, September 8.

48. *Papilio glaucus* L., Tiger Swallowtail.—Emmet: June 2–August 25. Cheboygan: (May 27) June 9–July 30. Our specimens resemble race *canadensis* R. & J., but Klotz includes Michigan in the range of the more southern *P. g. glaucus*.

This is one of the common June butterflies, with stragglers (usually in more or less ragged condition) occasionally found later in the summer. It sometimes occurs in large numbers at moist sand, and the species has also been taken on manure. It has been observed to visit a wide variety of flowers: Alfalfa, Burdock, Clintonia, Common Milkweed, Fireweed, Hedge-nettle, Huckleberry, Lilac, Orange Hawkweed, Pink, Swamp Thistle, Swamp Valerian, White Sweet Clover, Wild Blue Iris, Wild Parsnip, and Yellow Puccoon. Males are far more abundant than ♀♀ (cf. Clark, 1932, p. 186).

Other county records: Alcona, June 10; Charlevoix, July 7; Iosco, June 10; Leelanau, July 29; Mackinac, June 4–July 16; Montmorency, July 10; Oceana, June 28; Otsego, July 10.

Papilio troilus L., Green-clouded or Spicebush Swallowtail.—Probably cannot be expected in the Douglas Lake region, except as a stray, since neither Spicebush nor *Sassafras* occurs that far north in the state, and Prickly Ash, on which the larva has also been reported, is very uncommon.

Other county records: Oceana, June 27.

Family PIERIDAE—The Whites, Yellows, and Orange-tips

49. *Euchloe olympia* Edw., Olympian Marble.—Cheboygan: (May 12)–May 29. Material from northern Michigan evidently is *E. o. rosa* Edw. or near it. Sherman Moore took this species on May 12, 1921, on the shore of Duncan Bay, east of Cheboygan. There are three specimens in the Museum of Zoology taken by I. J. Cantrall May 29, 1939, in the aspen-birch-maple woods just southeast of the Biological Station. My only specimens were taken in Presque Isle County in 1951; some were along the roadside of U. S. 23 near Grand Lake and others were in the same area as *Incisalia polios* and *augustinus* near the shore of Lake Huron.

Other county records: Presque Isle, May 14.

50. *Colias eurytheme* Bdv., Orange Sulphur.—Emmet: June 12–September 30. Cheboygan: July 4–September 5. The above records include intermediate "hybrids" as well as typical deep orange *eurytheme*. The depth of color is extremely variable, and the intermediates are presumed to be hybrids with *philodice*.

The peak of abundance of this common species is August. In addition to visiting damp puddles in roads, it stops at the flowers of Aster (including Large-leaved Aster), Bush Honeysuckle, Joe-Pye Weed, and Orange Hawkweed.

Some albino *Colias* ♀♀ from Emmet, Cheboygan, and Mackinac counties are probably this species.

Other county records: Mackinac, July 2–August 26.

51. *Colias philodice* Godt., Clouded Sulphur.—Emmet: May 23. June 13–August 21. Cheboygan: May 28. June 21–September 5. Only clear yellow specimens, with no tinge of orange, are included in the above records.

The "Mud Puddle Butterfly" is common at puddles and damp sand, and has also been seen to visit Alfalfa, Aster, Coreopsis, and Orange Hawkweed.

A few Emmet County albino ♀♀ taken in August of 1943 may be this species rather than *eurytheme*. Albino ♀♀ of *Colias* were very common that month, but have occurred only occasionally since.

Other county records: Charlevoix, July 7; Luce, August 9; Mackinac, August 9.

52. *Colias interior* Scud., Pink-edged Sulphur.—Emmet. June 26-July 8. Cheboygan: June 29-August 9.¹⁴ With the exception of a single specimen, not noticed until 1950, when it was common in sphagnum bogs. In 1951, it was abundant throughout, especially in bogs (sphagnum and Leatherleaf) and neighboring dry woods and at mud puddles.

The ♂♂ have wider black borders than *philodice*—as wide as *eurytheme*; ♀♀ are bright yellow (seldom lighter than ♂♂) and always have some trace or even several spots of black border at the outer angle of the secondaries. The underside of the secondaries is clear yellow, with a single discocellular spot. A ♀ taken near Cheboygan, June 29, 1951, with a large number of typical specimens combines the characteristics of *interior* and *philodice*, and A. B. Klots, who has the specimen, suggests that it must be a hybrid.

Common in crowds at low spots in sphagnum in bogs, at mud puddles (1951), and noted on a number of flowers. Cow-wheat seems to be the favorite flower, but others include Butterfly-weed, Calopogon, Orange Hawkweed, Sheep Laurel, Swamp Candles, and Swamp Milkweed.

53. *Eurma lisa* Bdv. & Lec., Little Sulphur.—Emmet: (June 26) July 8-August 14. Scarce. One specimen taken July 8, 1944, in Mackinaw City, by Mrs. D. O. Voss. On August 14 of the same summer, I took another. About ten years ago I saw several of these butterflies along the rocky shore at McGulpin Point west of Mackinaw City. In the Museum of Zoology there is a ♀ taken by Newcomb at Mackinaw City (Emmet Co.) on June 26, 1931,¹⁵ and a ♂ taken by him at Cecil Bay on June 30, 1931.

The only flower record I have is Dandelion.

Other county records: Oceana, June 28 (common in 1944).

54. *Pieris rapae* L., Cabbage Butterfly.—Emmet: June 3-September 30. Cheboygan: July 15-September 5. Common all summer long. This species was abundant at Dog Mustard in the Mackinaw City dump in 1950. It also is evidently fond of sipping moisture at damp sand, and of Asters and Catnip. Two specimens were taken on the orchid *Calopogon* in Mud Lake Bog. Other flower notes include Alfalfa, Burdock, and Hoary Vervain.

Other county records: Charlevoix, July 5-July 7; Mackinac, August 9-20.

55. *Pieris protodice* Bdv. & Lec., Checkered White.—Emmet: June 2-August 31. Cheboygan: (May 12) August 19-August 26. Commonest during the first three weeks of August, this species is never abundant. I have taken it most often on the wing, but have also noted it at damp ground and on Silverweed. The May 12 specimen is the spring form *vernalis* Edw., and was taken by Moore in 1922.

Other county records: Mackinac, August 20; Oceana, n. d. (1941 or 1942).

56. *Pieris napi oleracea* Harris, Mustard or Grey-veined White.—Emmet: (May 23) June 17-August 1. Cheboygan: (May 12) May 13-August 18. Not very common until 1950, when it was abundant in the latter part of July at mud puddles and neighboring White Sweet Clover along roadsides in Springvale Tp., in southern Emmet County (and probably elsewhere in the region). Has also visited Daisy Fleabane and damp sand on the Lake Michigan beach.

Other county records: Alger, August 8.

Family HESPERIIDAE—The Skippers

57. *Thorybes pylades* Scud., Northern Dusky-wing.—Emmet: June 12-July 18. Cheboygan: June 14-July 2. An abundant skipper in early summer sunning along roadsides and at moisture by roadside ditches. Several have been noted on manure, and one on Red Clover. A ♀ was observed ovipositing on Clover on June 30, 1945.

¹⁴ Moore cites a May 28 date for *interior* in Cheboygan Co., but a ♂ *Colias* in the Museum of Zoology bearing the date May 28, 1920, and taken by Moore at Cheboygan, although labeled as *interior* is actually *philodice* and bears a note to that effect by Hovanitz.

¹⁵ The specimen is labeled June 20, but Moore writes me that according to Newcomb's notebook he was collecting near Mackinaw City on June 26, and probably the date should be that.

Other county records: Charlevoix, July 7.

58. *Pyrgus centaureae* Ramb., Grizzled Skipper.—Emmet: (May 23). Cheboygan: May 13. The Emmet County record is based on 2 ♂♂ and 2 ♀♀ in the Museum of Zoology, collected by Newcomb at Cecil Bay in 1932. My single Cheboygan County specimen is a ♂ taken in flight in Mud Lake Bog.

59. *Erynnis icelus* Scud. & Burg., Dreamy Dusky-wing.—Emmet: (May 28) June 6-July 12. Cheboygan: June 14-July 7. Another very common skipper of early summer. It does not visit flowers, but is common along roadsides, especially at puddles and damp spots in ruts.

60. *Erynnis juvenalis* Fabr., Juvenal's Dusky-wing.—Emmet: June 6, 1949. Taken only once, in the open aspen woods just north of French Lake; probably could be found earlier in the season. One was collected, and others seen, on Lousewort on Mackinac Island (Mackinac Co.) in 1950. Both specimens collected are ♂♂.

Other county records: Mackinac, June 21.

61. *Erynnis lucilius* Scud. & Burg., Columbine Dusky-wing.—Cheboygan: August 6-August 18. Found in 1950 in the Jack Pine plains south of Indian River, where the butterflies were sunning on twigs and visiting the flowers of Shrubby Cinquefoil.

62. *Carterocephalus palaemon mesapano* Scud., Arctic Skipper.—Emmet: June 20-July 1. Not very common, but rather easily overlooked on account of its small size and low habits. Found along sunny roadsides and weedy patches.

63. *Ancyloxypha numitor* Fabr., Least Skipper.—Emmet: July 8-August 23. My only specimen was taken from the clutches of a white crab spider on Ox-eye Daisy in 1946 along the rocky shore west of McGulpin Point. There are three specimens in the Museum of Zoology taken by Moore in 1921 on Waughoshance Island.

64. *Hesperia leonardus* Harris, Leonard's Skipper.—Emmet: August 9-September 2. Cheboygan: August 4-August 19. The spots on the secondaries beneath are white or occasionally yellowish-white. The butterfly is particularly common in August on the open prairie-meadow in the Jack Pine plains, where it is fond of Blazing-star. Other flower records, there or elsewhere, are Joe-Pye Weed, Pearly Everlasting, and Swamp Thistle; one specimen has Milkweed pollinia on its tarsi.

65. *Hesperia sassacus* Harris, Indian Skipper.—Emmet: June 18-(June 22). Cheboygan: June 14-June 22. Rather common in late June along sunny roadsides south of Mackinaw City, sunning and at damp ground by roadside ditches. Taken on Lousewort on Mackinac Island.

Other county records: Mackinac, June 21.

66. *Hesperia laurentina* Lyman, Laurentian Skipper.—Emmet: July 30-(August). Cheboygan: August 23-August 26. Quite common in late August on the abandoned Mackinaw City golf course, where it is most fond of Pearly Everlasting, with Canada Thistle and Goldenrod also frequently visited. Other flower records are Aster, Black-eyed Susan, Red Clover, and Wild Carrot. On cloudy days, the butterflies are more given to lighting among the grasses than upon flowers. There is a great deal of variation in the relative amounts of green and brown scaling on the under surface of the secondaries. At least during the few days collected, ♀♀ far outnumbered ♂♂.

Other county records: Mackinac, August 9.

67. *Polites themistocles* Latr., Tawny-edged Skipper.—Emmet: June 13-June 22. Cheboygan: June 14-July 7. A common skipper along roadsides, being most common at moist earth by ditches. Also recorded from Orange Hawkweed and Red Clover.

Other county records: Mackinac, July 16.

68. *Polites peckius* Kby., Peck's Skipper.—Emmet: July 2-July 25. Cheboygan: July 7-July 26. Not so common as the preceding species, Peck's Skipper occurs a little later in the season and evidently visits flowers more freely. Noted on Canada Thistle, Common Milkweed, Hedge-nettle, and Swamp Milkweed.

69. *Polites mystic* Scud., Long Dash.—Emmet: June 20-July 12. Cheboygan: June 21-July 16. August 2. Common in late June and on into early July. Another roadside skipper, fond of damp spots. Also seen on Meadow Lobelia, Orange Hawkweed, and Selfheal.

70. *Wallengrenia otho egeremet* Scud., Broken Dash.—Cheboygan: July 20-August 9. Evidently rather local. Taken on Joe-Pye Weed and, especially, Lavendar Wild Bergamot. Frequently in company with *Atrytone ruricola*, which it superficially resembles.

71. *Poanes hobomok* Harris, Mormon or Hobomok Skipper.—Emmet: June 6-July

1. Cheboygan: June 14-July 1. July 17. Common in June along roadsides and in open places, where it stops to sun itself, or at a damp spot. Recorded as visiting Lousewort and Wild Black Cherry.

72. *Atrytone bimacula* G. & R., Two-spotted Skipper.—Cheboygan: June 29-July 7. The Cheboygan County specimen (a ♂) in the Museum of Zoology is labeled "Reese's Bog, vi-29-34. C. F." 16 My four specimens (others were seen) were taken in 1950 along a sandy road through marshy ground at Elliott's Creek, two miles east of Cheboygan. Special searching for this rare skipper in the same spot several times during July, 1951, was unproductive.

73. *Atrytone ruficola metacomet* Harris, Dun Skipper.—Emmet: July 25-August 9. Cheboygan: July 26-August 18. Rather common, and partial to pink or rose-colored flowers. Records indicate visits of this species to Boneset, Common Milkweed, Dogbane, Joe-Pye Weed, Lavendar Wild Bergamot, and Swamp Thistle.

74. *Amblyscirtes vialis* Edw., Roadside Skipper.—Emmet: (May 30) June 14-June 21. Cheboygan: May 29. June 14-June 21. As implied by its specific name, this skipper is found along roadsides. Noted sunning, at damp spots, and on blossoms of Wild Strawberry. Not very common.

BOTANICAL REFERENCE LIST

The flowering plants mentioned in the preceding pages by common names are here listed in alphabetical order, followed by their scientific names as given in the 8th edition of Gray's *Manual* (Fernald, 1950). Plants mentioned in habitat descriptions are included, as well as those referred to as larval food plants or as having flowers visited by adult butterflies.

Alder, *Alnus rugosa*; Alfalfa, *Medicago sativa*; American Elm, *Ulmus americana*; Aspen, *Populus grandidentata* (Large-toothed A.) and *P. tremuloides* (Quaking A.); Aster, *Aster* spp.; Bastard Toadflax, *Comandra richardsoniana*; Beach Pea, *Lathyrus japonicus* var. *glaber*; Bearberry, *Arctostaphylos uva-ursi*; Birch (= Paper or White Birch), *Betula papyrifera* and its var. *cordifolia*; Black-eyed Susan, *Rudbeckia serotina*; Black Oak, *Quercus velutina*; Blazing-star, *Liatris cylindracea*; Blueberry, *Vaccinium* spp., including *V. angustifolium*, *V. a.* var. *nigrum*, & *V. myrtilloides*; Blue-stem Goldenrod, *Solidago caesia*; Boneset, *Eupatorium perfoliatum*; Burdock, *Arctium minus*; Bush Honeysuckle, *Diervilla lonicera*; Butter-and-Eggs, *Linaria vulgaris*; Butterfly-weed, *Asclepias tuberosa*; Calopogon, *Calopogon pulchellus*; Canada Goldenrod, *Solidago canadensis*; Canada Thistle, *Cirsium arvense*; Catnip, *Nepeta cataria*; Cat-tail, *Typha latifolia*; Cherry, *Prunus* spp.; Clintonia, *Clintonia borealis*; Clover, *Trifolium* spp.; Common Buttercup, *Ranunculus acris*; Common Milkweed, *Asclepias syriaca*; Coreopsis, *Coreopsis lanceolata*; Cow-wheat, *Melampyrum lineare*; Daisy Fleabane, *Erigeron philadelphicus*; Dandelion, *Taraxacum officinale*; Dogbane, *Apocynum androsaemifolium*; Dog Mustard, *Erucastrum gallicum*; Fireweed, *Epilobium angustifolium*; Flat-topped Goldenrod, *Solidago graminifolia*; Goldenrod, *Solidago* spp.; Hedge-nettle, *Stachys palustris*; Hoary Vervain, *Verbena stricta*; Huckleberry, *Gaylussacia baccata*; Jack Pine, *Pinus banksiana*; Joe-Pye Weed, *Eupatorium maculatum*; Lake Huron Tansy, *Tanacetum huronense*; Large Cranberry, *Vaccinium macrocarpon*; Large-leaved Aster, *Aster macrophyllus*; Lavendar Wild Bergamot, *Monarda fistulosa*; Leatherleaf, *Chamaedaphne calyculata*; Lilac, *Syringa vulgaris*; Lousewort, *Pedicularis canadensis*; Maple, *Acer* spp., mostly Sugar Maple, *A. saccharum*; Meadow Lobelia, *Lobelia spicata*; Meadowsweet, *Spiraea alba*; Milkweed, *Asclepias* spp. (see Butterfly-weed, Common Milkweed, Swamp Milkweed); Ninebark, *Physocarpus opulifolius*; Orange Hawkweed, *Hieracium aurantiacum*; Ox-eye Daisy, *Chrysanthemum leucanthemum* var. *pinnatifidum*; Pearly Everlasting, *Anaphalis margaritacea* var. *intercedens*; Pink, *Dianthus* sp.; Prickly Ash, *Xanthoxylum americanum*; Quaking Aspen, *Populus tremuloides*; Red Clover, *Trifolium pratense*; Red Oak, *Quercus rubra* var. *borealis*; Red-osier Dogwood, *Cornus stolonifera*; Red Pine, *Pinus resinosa*; Rough-fruited Cinquefoil, *Potentilla recta*; Sand Cherry, *Prunus pumila*; Sassafras, *Sassafras albidum*; Selfheal, *Prunella vulgaris*; Serviceberry, *Amelanchier* spp.; Sheep Laurel, *Kalmia angus-*

16 Reese's Bog is at the north end of Burt Lake and is dominated by White Cedar, with a few roads and clearings. The initials presumably are those of Charles Farrell, who was enrolled in the entomology course at the Biological Station in 1934.

usifolia; Sheep Sorrel, *Rumex acetosella*; Shrubby Cinquefoil, *Potentilla fruticosa*; Silverweed, *Potentilla anserina*; Small Cranberry, *Vaccinium oxycoccos*; Spicebush, *Lindera benzoin*; Squirrel Corn, *Dicentra canadensis*; Swamp Candles, *Lysimachia terrestris*; Swamp Milkweed, *Asclepias incarnata*; Swamp Thistle, *Cirsium muticum*; Swamp Valerian, *Valeriana uliginosa*; Sweet-Fern, *Comptonia peregrina*; Sweet Flag, *Acorus calamus*; Touch-me-not, *Impatiens capensis*; Turtlehead, *Chelone glabra*; Violets, *Viola* spp.; White Cedar, *Thuja occidentalis*; White Pine, *Pinus strobus*; White Sweet Clover, *Melilotus alba*; Wild Black Cherry, *Prunus serotina*; Wild Blue Iris, *Iris versicolor* and *I. virginica* var. *shrevei*; Wild Carrot, *Daucus carota*; Wild Parsnip, *Pastinaca sativa*; Wild Strawberry, *Fragaria virginiana*; Willow, *Salix* sp.; Yarrow, *Achillea millefolium*; Yellow Puccoon, *Lithospermum croceum*.

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ADDENDA

During the 1952 season, collecting by W. H. Wagner, Jr., and Howell V. Daly, Jr., contributed to our knowledge of northern Michigan butterflies. The following are the more significant records obtained by one or more of us.

Two species previously listed for Emmet County were captured for the first time in Cheboygan County, and one other was seen, thus raising the total number of species known for this county from 67 to 70. The two species taken were *Eurema lisa*, collected (Daly & Voss) July 11 at the Biological Station, where it was flying low and lazily; and *Coenonympha tullia inornata*, taken on the Mackinaw City golf course on June 19 (2 ♂♂) and July 2 (♀). In addition, Wagner reports having seen *Ancyloxypha numitor* several times in the county.

For the first time since 1944, *Precis lavinia coenia* was seen in the region, a specimen having been taken near Alanson (Emmet Co.) by Daly, on June 25. *Vanessa cardui* was unusually abundant in 1952, being found in Cheboygan County from June 14 to July 29. Specimens of *Limnitis arthemis* approaching *astyanax* were more numerous than usual. *Colias interior* continued to be common.

Strymon falacer was locally common in Cheboygan County July 4-7. It was first noticed by Wagner, on the flowers of Sumac (*Rhus glabra* var. *borealis*) at the Biological Station. Later it was found there and near Elliott's Creek (2 miles east of Cheboygan) on Common Milkweed; one individual was also seen on White Sweet Clover. *S. liparops strigosa*, although less common, occurred with *falacer* on Sumac and Milkweed in both localities. A ♀ *Atrytone bimacula* was taken by Wagner on July 5 at the Elliott's Creek locality.

Known flight periods of several species were extended, none for much more than two weeks except for certain spring observations. Wagner took *Polygona faunus*, *P. progne*, and *Incisalia augustinus* in Wilderness State Park (Emmet Co.) on April 26, and reported seeing *Lycaenopsis argiolus pseudargiolus*, *Nymphalis antiopa*, and *N. j. album*. I saw *Papilio glaucus* in Cheboygan County on May 18, and took several *Erynnis icelus* on that date, when it was abundant.

Other county records, several of them new, established during the 1952 season were as follows: Leelanau Co., July 26: *Speyeria cybele*, *Phyciodes tharos*, *Vanessa cardui*, *Precis lavinia coenia*, *Everes comyntas*, *Plebeius saepiolus*, *Eurema lisa*, *Pieris rapae*, and *Epargyreus clarus*. Presque Isle Co., July 2: *Phyciodes tharos*, *Nymphalis milberti*, *Limnitis arthemis arthemis*, *Papilio glaucus*. Schoolcraft Co., Seul Choix Point, July 13 (Daly & Voss): *Lethe eurydice*, *Cercyonis pegala nephele*, *Speyeria cybele*, *S. atlantis*, *Boloria selene*, *Phyciodes tharos*, *Nymphalis milberti*, *N. antiopa*, *Vanessa cardui*, *Precis lavinia coenia*, *Limnitis arthemis arthemis*, *Everes comyntas*, *Plebeius saepiolus*, *Colias philodice*, *C. interior*, *Eurema lisa*, and *Polites mystic*.

The following new records of flower (and other) visitations include several plants not noted in previous years as attracting butterfly visitors.

NYMPHALIDAE: *Speyeria cybele*, Blueweed (*Echium vulgare*); *S. aphrodite*, Blueweed, Hill's Thistle (*Cirsium hillii*); *Melitaea necteis*, Common Milkweed; *Phyciodes tharos*, Canada Thistle, and one individual on a dead *P. tharos*; *Nymphalis milberti*, Coreopsis, Canada Thistle; *Vanessa cardui*, moist spots in dirt road, Blueweed, and Canada Thistle most preferred—also on Hoary Vervain, Knapweed (*Centaurea maculosa*), Ox-eye Daisy, Wild Carrot, and Wild Parsnip; *V. virginienensis*, Canada Thistle; *Precis lavinia coenia*, Swamp Milkweed; *Limnitis arthemis astyanax*, Canada Thistle; *L. archippus*, Wild Carrot.

LYCAENIDAE (See also *Strymon*, 4th paragraph above.): *Lycaena phlaeas americana*, King Devil (*Hieracium florentinum*); *L. epixanthe michiganensis*, one individual seen extending its proboscis on the expanded summit of the pistil of a flower of Pitcher-plant (*Sarracenia purpurea*) which had dropped its petals; *Everes comyntas*, Red Clover, White Sweet Clover; *Plebeius saepiolus*, White Clover (*Trifolium repens*).

PAPILIONIDAE: *Papilio glaucus*, Horned Bladderwort (*Utricularia cornuta*).

HESPERIIDAE: *Epargyreus clarus*, Common Milkweed; *Hesperia sassacus*, Orange Hawkweed; *Polites themistocles*, Bristly Sarsaparilla (*Aralia hispida*), Hill's Thistle; *P. peckius*, Fireweed; *P. mystic*, Buttercup (*Ranunculus* sp.), Orange Hawkweed, White Clover; *Amblyscirtes vialis*, Orange Hawkweed.

Observations on the Biology of Ten Notonectoid Species Found in the Douglas Lake, Michigan Region

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The notonectoid Hemiptera are well represented in the region of Douglas Lake, Michigan, by nine species of Notonectidae and one of Pleidae. In the Notonectidae we find *Notonecta borealis* Bueno and Hussey, *N. irrorata* Uhler, *N. insulata* Kirby, *N. undulata* Say, *N. lunata* Hungerford, *Buenoa margaritacea* Torre-Bueno, *B. elegans* (Fieber), *B. limnocastoris* Hungerford, and *B. macrotibialis* Hungerford, while the Pleidae is represented by *Plestriola* Fieber. The area surrounding the University of Michigan Biological Station is therefore an ideal place to study the biology and ecology of these insects.

The writer undertook this study in 1927 because nothing was known concerning the life history of *N. borealis* Bueno and Hussey or of the other typically northern species. Moreover it was desirable to check the life histories in the north of those species studied by Hungerford in other regions.

ACKNOWLEDGMENTS

The writer wishes to thank Dr. A. H. Stockard and other members of the University of Michigan Biological Station for their assistance in making it possible to carry out this study; Dr. Hungerford for the suggestion of the problem and invaluable suggestions during the study; Miss Aline Rudolphi for the drawings.

NOTONECTA UNDULATA Say

Notonecta undulata has the widest distribution of any of the American *Notonecta*, Quebec to the Gulf and from coast to coast. Therefore, it must adapt itself to a variety of ecological conditions, the extreme cold of the north, the dryness, severe heat and cold of the west and the extremely variable conditions of the south. However, it grows less abundant in the south where it is replaced by *N. indica* Linn. Hungerford (1919) states that *N. undulata* seems to be able to adapt itself to a wider range of conditions than *N. irrorata*, *N. insulata*, and *N. lunata*. In this region it ranges from shallow stagnant pools and streams to deep cold springs and bog pools.

Nymphs collected in the field June 30, 1936 were in the third and fourth instars and showed a wide range in the time it took them to transform into adults. One specimen collected July 7 transformed from the fourth instar to the fifth July 8 and from the fifth to an adult July 31; another collected July 6 changed from the fourth instar to the fifth July 27 and from the fifth to an adult July 30.

Fecundity.—The adults which emerged in the laboratory or were collected in the field did not deposit any eggs or show any developing ova with one exception. July 3, one female was taken in a small, shallow, muddy pool in a field. All stages of development from eggs to fifth instars were present in this pool. This female was placed with a male which was collected June 30; they began mating at once and the first eggs were noticed July 6.

She laid the following number of eggs between July 6 and her death August 12: July 6 to 8—35, July 8 to 16—50, July 16 to 26—80, July 26 to 28—0, July 28 to 30—20, July 30 to 31—0, August 1 to 3—40, August 3 to 12—0—a total of 225 eggs in 28 days. There is no doubt that this female was of the over-wintering generation.

Again in 1937 a number of adult females were collected in a gravel pit June 2, and July 9. These adults deposited eggs the next day in each case and continued to do so until death the first week of August. No females collected in the field after July 9, 1937, July 19, 1938, July 12, 1939 or any of those which emerged in the laboratory deposited eggs. Upon dissection they showed no developing eggs. The adults which deposited eggs were rather scarce at any time and always had the torn and dirty appearance of old forms, while the freshly emerged adults were very bright. Since some of these females are known to live until August 12 in the laboratory and may live even longer in the field, the great number of nymphs ranging from the first to the fifth instar observed in the field may be accounted for. There is a question as to what becomes of these late emergers. Since it takes about 50 days for the development from egg to adult and ice begins to appear by the middle of September, the very young ones may not reach adult stage at all. Clark (1928) states that at Winnipeg the ice formed to a depth of 1.7 meters and at the end of the autumn drought none of the permanent pools were more than 1.2 meters deep so that they were frozen solid. In the early spring, the bottom of a pool was dug up. *Notonecta undulata* was found at a depth of 10 to 13 cm. under the bottom mud and debris. On being taken to the laboratory they revived in some instances, but more frequently their hibernation proved fatal. Approximately the same conditions exist at Douglas Lake, Michigan, the water in the lake often freezes to a depth of 15 to 24 inches by November and may be 2 and 3 feet thick by April. The adults may migrate to deep water and return to the shallow pools in the spring or burrow in the mud, but there is no indication that the nymphs can do this.

Life history.—The life history of this form has been thoroughly discussed by Hungerford (1920) and other authors. A key to the first and fifth instar nymphs is given under the general description of nymphs. The egg is compared to other notonectoid eggs under the discussion of eggs and egg patterns.

NOTONECTA LUNATA Hungerford

This small, white species prefers clear cool pools and slow flowing water which contains an abundance of plants. This species was taken in all the pools of this type in the Douglas Lake region. It clings to plants beneath the water and may be collected in great numbers by dragging a net rapidly through the vegetation.

Observations.—Many adults and nymphs from the egg to fifth instar were collected in two small streams July 3 and 4, all years of observation.

The adults continued to deposit eggs in the laboratory until the death of the last female July 16.

Adults which transformed in the laboratory or were collected in the field after July 20 did not deposit any eggs, and the females which were dissected from time to time did not show any developing ova.

The last field collection August 3 showed many adults and fourth and

fifth instar nymphs. This seemed to indicate that the developmental season was about over and that the present adults would winter over.

Since none of the adults from emerging nymphs deposited any eggs and it takes about 50 days to pass from the egg stage to adult stage, one is probably safe in saying that there is only one generation a year in this locality.

Abundance.—In this region, though restricted to a special habitat, *N. lunata* has ranked in abundance next to *N. undulata* during the 6 summers of observation by the author. Hussey (1919) ranks *N. borealis* as next to *N. undulata* in abundance and states *N. lunata*, or *N. variabilis* as he calls it, was only abundant during August. The reason for this statement is probably due to the fact that all of the *N. borealis* reach adult stage by July 1 and the majority of *N. lunata* do not reach adult stage until the last week of July. He probably did not recognize the immature stages of this form.

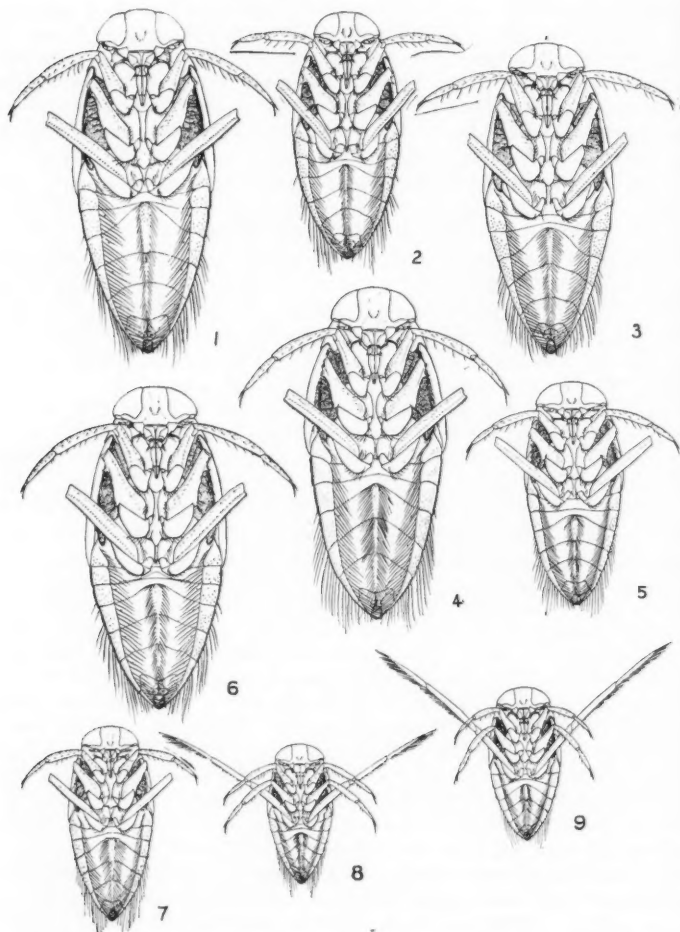
Life history.—See general discussion of nymphs and eggs.

NOTONECTA INSULATA Kirby

This large back-swimmer is rather rare in this region. Seven specimens were taken in 1918 by Hussey, a few by Hungerford (1925, 1928, 1930-1932). The author and Dr. Hungerford took two adults and twenty nymphs from a gravel and marl pit pool (1936); on June 24, 1937 great numbers of nymphs were seen and a few taken from a clay pit near the Biological Station. Ten days later great numbers of adults were seen in the pool; these had emerged from fifth instar nymphs since the last visit. In 1938 due to the removal of clay, the clay pit pool was very small and shallow. As a result, life was very concentrated on June 26; nymphs of both *N. insulata* and *N. irrorata* were in considerable abundance; 2 third instar, 5 fifth instar and 2 adult *N. insulata* were collected. By July 6 the pool was only 6 inches deep and most of the nymphs had emerged into adults. Six days later the pool was dry and all life had migrated or died. On June 25, 1939 this pool contained considerable water but showed no *N. insulata* and very few *N. irrorata* and *N. undulata*. The gravel pit on the Pellston road which was the only place specimens were found in 1936 was lacking in this form when visited on June 26, 1937. This may be partly due to the changed condition in this pool. In 1937 the shallow portion of the pool where most of the nymphs were found in 1936 dried up, leaving only a small spring-fed pool 10 x 8 ft. long and 2 to 3 ft. deep at one end. No nymphs but large numbers of *N. irrorata*, and *N. undulata* adults were present. Therefore if any of the nymph survived the high temperature of the shallow portion of the pool they must have emerged into adults and migrated to other waters. In 1938 this pool had plenty of water which ranged from 3 to 4 ft. in depth at the deeper end and adult *N. insulata* were very numerous in the deeper part. Seven adults were brought to the laboratory. On July 1, 1939 this pool showed very few *N. insulata* nymphs and all except the deep hole was dry by July 25. Again, on July 3, 1949 five fourth and fifth instar nymphs were taken and emerged in the laboratory one to two weeks later. Migrations by the adults seem common when environmental conditions are not favorable. In 1936 a male JK₄ which had emerged in the laboratory on July 11 disappeared from his dish on August 6, and since he was not found in the

laboratory he probably flew out the window. Six of twelve adults collected July 8, 1937 escaped from under a screen covering of an aquarium before the hole was discovered. One found a short distance from the aquarium was caught and returned before it could fly away. Out of two or three hundred

PLATE I



Figs. 1-9.—1. Fifth instar of *N. insulata*; 2. Fifth instar of *N. lunata*; 3. Fifth instar of *N. undulata*; 4. Fifth instar of *N. borealis*; 5. Fourth instar of *N. borealis*; 6. Fifth instar of *N. irrorata*; 7. Fourth instar of *N. irrorata*; 8. Third instar of *N. irrorata*; 9. Third instar of *N. borealis*.

adults kept in the laboratory only *N. insulata* and *N. undulata* have ever tried to escape from the aquarium.

The environmental conditions may be responsible for the scarcity of this form. Hungerford (1933) states that "Long ago Doctor Uhler pointed out that this insect prefers cool waters" and "Van Duzee has reported it in stagnant pools having clayed bottoms near Buffalo, N. Y." Since it has only been taken in large numbers in clay pools in Michigan, it seems that this may be one of the controlling factors. It would be interesting to check a large number of clay pits to see if this preference is true.

Life history.—Little is known about the life history of this form beyond the first instar. Hungerford at Ithaca, N. Y., brought in a mating pair as early as April 29, got eggs April 30 and these hatched May 23, but was unable to carry them beyond the first instar.

What the egg laying date is in Michigan is not known but the first emergence of fifth instar nymphs in 1936 was July 8, in 1937, July 6. One third instar nymph was taken July 4, 1937 and emerged as an adult July 31. Therefore this one required 27 days to complete the fourth and fifth instars and part of the third. The lack of ova in any of the emerging adults as late as November 28, seems to indicate that they over-winter as adults.

THE EGG

Size.—Length, 2.21 mm.; height, viewed laterally, .78 mm.; width viewed from above, 1.754 mm.

Color.—White, with surface quite strongly reticulate so that surface is rough. The chorion is quite tough.

Shape.—Elongate oval, micropylar end somewhat truncate; caudal end more pointed.

As with other Notonectid eggs the micropyle is a curved truncate cylindrical peg.

The egg is attached to the plant stem or other support by a transparent pad of mucilaginous material. This egg according to measurements and comparative drawings made by Dr. Hungerford is larger than that of any of the other four species of *Notonecta* including the egg of the very large *Notonecta borealis*. The sculpturing on the chorion of shells found attached to a submerged dead branch of a tree is quite interesting in that the chorion is very thick and punctured by a series of holes which make a definite pattern. Pl. 3, Figs. 6-7. According to Poisson (1933) these holes are probably respiratory structures.

FIFTH INSTAR

Size.—Length, 14.8 mm.; width of body, 4.7 mm.; width of head, 2.86 mm.; vertex, .9 mm.; synthlipsis, .6 mm.

Color.—In dorsal view, eyes dark red, thorax white with greenish tinge; prothorax with smoky band near each lateral margin and parallel with it. Posterio-lateral angle smoky, mesothoracic wing pad without smoky lines, the abdomen is usually white crossed by three wide and one narrow smoky bands, basal portion of abdomen lacking wide smoky bands, caudal portion white. Wing pad extends to second abdominal segment.

Structural peculiarities.—Ventral view, median abdominal carina long and appears to be in three parts, the first part has a long narrow naked space surrounded by comparatively short hair; next two spaces small; ventral front tibia with five short setae on anterior edge; seven long setae on posterior edge; middle tibia with seven strong setae on posterior margin; middle femur has besides the posterior clump of four setae on a large tubercle, six other setae on very small tubercles and a strong spine-like subapical protuberance. Pl. I, Fig. 1.

FOURTH INSTAR

Size.—Length, 8.08 mm.; width of body, 3.2 mm.; width of head, 2.3 mm.; vertex, .66 mm.; synthlipsis, .55 mm.

Color.—Markings on body not so pronounced; black bands very faint on mid dorsal region of abdomen; wing pads extend almost to first abdominal segments; peculiarities same as in the fifth instar; second part of carina exposed; third part covered by hairs.

THIRD INSTAR

Size.—Length, 5.77 mm.; width of body, 2.47 mm.; width of head, 1.85 mm.; vertex, .66 mm.; synthipsis, .49 mm.

Color.—All markings very faint; wing pads extend one third way back to first abdominal segment.

Structural peculiarities.—Second and third part of carina covered by hairs; front tibia with four distinct setae upon posterior margin; middle femur with six setae on posterior margin. For description of the second and first instars see Hungerford (1920).

NOTONECTA IRRORATA Uhler

A large velvety brick and black *Notonecta* was very abundant in all of the deep pools and slow streams containing vegetation in 1936. In one case on July 27 one sweep of a net through vegetation in a cool, well shaded, slow moving stream (Mud Creek) by Black Lake, produced twenty-five specimens. Over one hundred and twenty-five specimens were collected in a few minutes. They were about one half males and one half females. There was one exception to the habitat mentioned above. Great numbers of both nymphs and adults were found in a gravel pit pool on Pellston Road (Highway 31) which varied in depth from four inches to two and a half feet. This pool contained a heavy marl deposit and during two weeks of intense hot weather, the water became really hot and evaporated rapidly. This seemed to diminish the numbers to some extent, and caused them to move to the deeper end or change into adults. On July 20 several nymphs were picked up in water less than one inch deep; only two of these were *N. irrorata*, the rest were *N. undulata* and the whole group transformed into adults within twenty-four hours after being brought into the laboratory.

In 1937 this species was very scarce at all of the stations where it was abundant in 1936. Only four nymphs were collected at the gravel pit on Pellston Road, one nymph and four adults at Bryants Bog and only two adults in Mud Creek at Black Lake where they were in great abundance in 1936. However they, both nymphs and adults, were fairly abundant in a new station, the clay pit near Maple River. In 1938 they were extremely scarce, only three adults and one nymph were taken all summer. The population in 1939 was average. In 1949 they were abundant every place a collection was made. The fluctuation in numbers and distribution seems to vary considerably from year to year. What factors control this are not known.

LABORATORY AND FIELD OBSERVATIONS

No adults were taken or seen on the first collecting trip June 30, 1946 at Bryants Bog pool but a few fourth and a great abundance of fifth instar nymphs were taken.

Adults were picked up in great numbers from this same pool July 7.

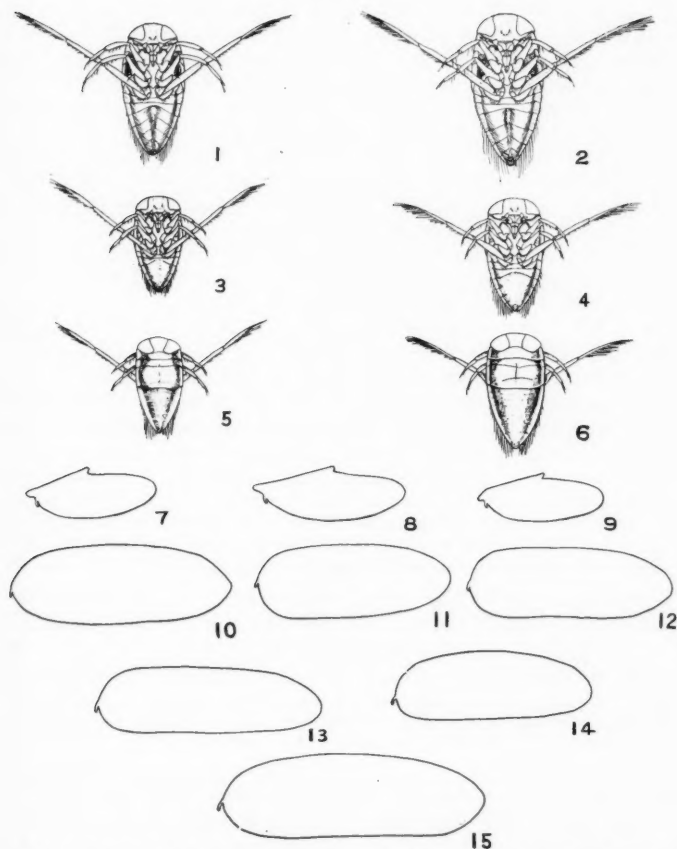
Nymphs brought in June 30 transformed to adults July 2 to 9. Many of those brought in July 7 emerged into adults July 8 to 12. Six brought in July 7 did not attempt to emerge until July 20 to 26 and died before they got completely out of the exuviae. Evidently the intense heat, change of food and general laboratory conditions had retarded and weakened them. One fourth instar nymph taken June 30 changed to the fifth instar on July 5 and to an adult July 31; another collected July 7 changed to fifth July

11 and to adult July 20. This gives an idea of the variability of the individuals.

Hungerford (1919) gives July 18 as the date of emergence of fifth instar nymphs collected in the field and kept in the laboratory and July 19 as the first date for the appearance of adults in the field.

The number of *N. irrorata* nymphs in the field diminished rapidly after July 13 and were replaced by *N. undulata* nymphs. Out of 25 nymphs taken

PLATE II



Figs. 1-15.—1. Second instar of *N. irrorata*; 2. Second instar of *N. borealis*; 3. First instar of *N. irrorata*; 4. First instar of *N. borealis*; 5. First instar of *N. irrorata*; 6. First instar of *N. borealis*; 7-15. Eggs. 7. *B. limnocastoris*; 8. *B. macrotibialis*; 9. *B. elegans*; 10. *N. borealis*; 11. *N. irrorata*; 12. *N. undulata*; 13. *N. lunata*; 14. *N. indica*; 15. *N. insulata*.

July 13, there were two *N. irrorata* and 23 *N. undulata*. The last date for an *N. irrorata* nymph to be taken in the field was July 20.

Hungerford (1920) does not give the last date for fifth instar nymphs to be taken in the field of New York, but does state that the first nymphs appeared in the laboratory May 18 and in the field the first week of June. And that the adults emerged in the laboratory July 18, and some freshly emerged adults were found in the field July 19. He also states that the egg stage of this species is comparatively long, some two or three weeks or even longer.

Due to the fact that we do not reach Michigan until the last week of June, nothing is known about the earlier stages of the life history of this species for this region. From the above statement the adults seem to appear here eleven days earlier than in New York and 30 to 40 days later than in Virginia and Kentucky. This difference may be due to normal early and late springs and the light winter and early spring of the South. No weather records are available for this region for spring and fall. The ice usually goes off from the middle to the last week of April. This varies with the general weather conditions. Information is needed on temperature necessary for egg laying and the rate of development of eggs.

Behavior.—During the height of emergence and until July 20, both adults and nymphs were near the surface of the water. After that date it was necessary to sweep deep in order to find them. By August 13 *N. irrorata* were rather scarce in the usual collecting pools. It seems that they had either migrated to deep water or to new locations.

All adults which emerged in the laboratory were paired. Many died but four pairs were still living August 20. These were increased from time to time by other pairs from the field. No eggs had been deposited up to August 20, and all dissected females showed no developing ova. Since ice appears on the pools by the end of September or first of October, it appears that the present adults may be the new over-wintering adults and that there is only one generation a year. Hungerford (1920) states that at Ithaca, N. Y. "it spends the winter months in the deeper ponds and spring-fed open pools, flying from these quarters to shallow waters for breeding."

Observations in Virginia and Kentucky.—April 14, 1937 three stems of smart weed bearing *Notonecta* eggs were taken from an old rock pit filled in the summer and used as a swimming pool near Amherst, Virginia. The water in this pool was four inches to one foot in depth with a rock and mud bottom covered with oak and maple leaves. Many grasses and weeds were growing at one end of the pool. Immature insects and tadpoles were abundant.

A very slight difference in size was noticed in these eggs when brought into the laboratory and examined under a microscope a difference in chorion markings indicated that there were two types of eggs. Several days later, nymphs emerged, one a whitish very slender form which was identified as a *N. indica* nymph, and a creamy plump one bearing a very dark abdomen. This dark form was reared through and proved to be *N. irrorata*. The identification of this form was doubtful until the adult emerged even though the nymphal stages checked as *N. irrorata* because Hungerford (1920) states that

this form inserts its eggs into stems and in this case all of the eggs were on the outside of stems mixed up with *N. indica* eggs. Why the eggs were not insterted is not known. However, these stems were covered over with a thick layer of algae and the eggs were embedded in this and the female may have concluded that they were well protected. Eggs were discovered in lily stems collected from a lily pool in Richmond, Kentucky, March 25, 1939. These stems were soft enough to allow most of the eggs to be inserted.

Laboratory rearing.—The eggs began to hatch April 20 and continued for a week. The form which was reared through hatched April 20, changed from first to second instar May 8, second to third May 13, third to fourth May 24, fourth to fifth June 6, and fifth to adult June 21, thus the complete developmental period required 62 days.

Out of 15 nymphs which hatched only one, a female, reached adult stage and lived until March 1, 1938. The death rate was high due to improper care under crowded laboratory conditions. Several reached the fourth instar and were accidentally killed.

What the conditions were in the field is not known as the author was unable, due to rains, to return to the pool where the eggs were collected. In 1938 many fourth instar nymphs were taken in the field during the third week of May. On April 25, 1939 several first instar nymphs hatched in the laboratory in Kentucky and were placed in a horse trough where they emerged as adults June 22 and 23, completing their life cycle in 59 to 60 days, which checks with the one reared in the laboratory in 1938.

A description of the egg and instar stages have been given by Hungerford (1920), a description of the chorion and a comparative table of measurements of this nymph and *N. borealis* is given under general discussion of *N. borealis* and egg patterns. Pl. 3, Figs. 4, 5.

NOTONECTA BOREALIS Bueno and Hussey

This large white northern form seems to prefer deep cool water. In 1927 they were found in abundance in two pools, one a deep bog lake (Bryants Bog), and the other a sedge, beach pool, and scatteringly in several other bog pools. In 1936, 1937 and 1938 they were found only in the deep bog pool. In 1939 a few eggs, one nymph and one adult were taken in the sedge beach pool where they had been so abundant in 1927. In 1949 they were very abundant in Bryants Bog, Sedge Pool, Nichols Bog, and Livingston's Bog.

Practically nothing is known about the life history of this form. A note was published by Hungerford (1934) on the unpublished observations of the writer in 1927.

Mating.—Field records for 1927 and 1936 showed no adults before June 29 and all of the nymphs were in the fifth instar and transformed into adults within 24 to 48 hours after they had been brought into the laboratory. All nymphs in the field had transformed into adults by July 6. On June 28, 1937 adults were emerging very rapidly. Great numbers of fresh adults were present and many exuviae were on the water around the vegetation. In 1949 three or four adults along with many fifth instar nymphs were collected June 28.

One female nymph A2 brought into the laboratory June 30, 1936 transformed into an adult July 1, was placed with two males the same day, was seen mating July 3, and deposited the first egg July 8.

A similar observation was made in 1927 of a female nymph which transformed June 30, mated July 4, and deposited her first eggs July 9.

Again in 1937 and 1938 females in laboratory deposited their first eggs July 9.

A male and a female nymph were brought in June 24, 1949; they emerged into adults June 27; were mating July 7 and the female laid her first eggs July 10. Thus it appears that the preoviposition period ranges between 8 and 13 days. Mating took place repeatedly during the lifetime of these specimens.

Oviposition.—As in the case of *N. irrorata* reported by Hungerford (1920), this species inserts her eggs singly in the tissues of plants. She prefers firm water soaked rushes, but when these are not available she will use any material present. If the tissue is too hard for the ovipositor to penetrate, the egg may be only partially inserted or remain entirely on the outside and will drop off very easily; if the tissue is soft they may be entirely hidden.

A groove is cut lengthwise of the tissue by scraping the ovipositor back and forth for several seconds. The time varies with the hardness of the substance. The egg is usually placed into the stem on a level and parallel with the surface. In some cases the opening closes completely hiding the egg; in others the anterior end of the egg may be exposed.

Fecundity.—*N. borealis* probably deposits a considerable number of eggs during her lifetime in the field. What the length of life is in the field is not known. The writer collected several females August 14, 1936 and in all cases they were very sluggish, discolored, and had very badly frayed hemelytra; several very badly disintegrated specimens were also brought up in the dip net. This observation was the same for all four years.

Three females were kept under observation in the laboratory from the time of transformation into adults, until their death, about a month later, and they deposited the following number of eggs:

| | Female B2 1927 | Female A2 1936 | Female BII 1937 |
|-------------------|-------------------|-------------------|--------------------|
| Transformed | Jun. 30 | Jul. 1 | Jun. 29 |
| Mated | Jul. 4 | Jul. 3 | |
| First eggs | Jul. 9 | Jul. 8 | Jul. 9 |

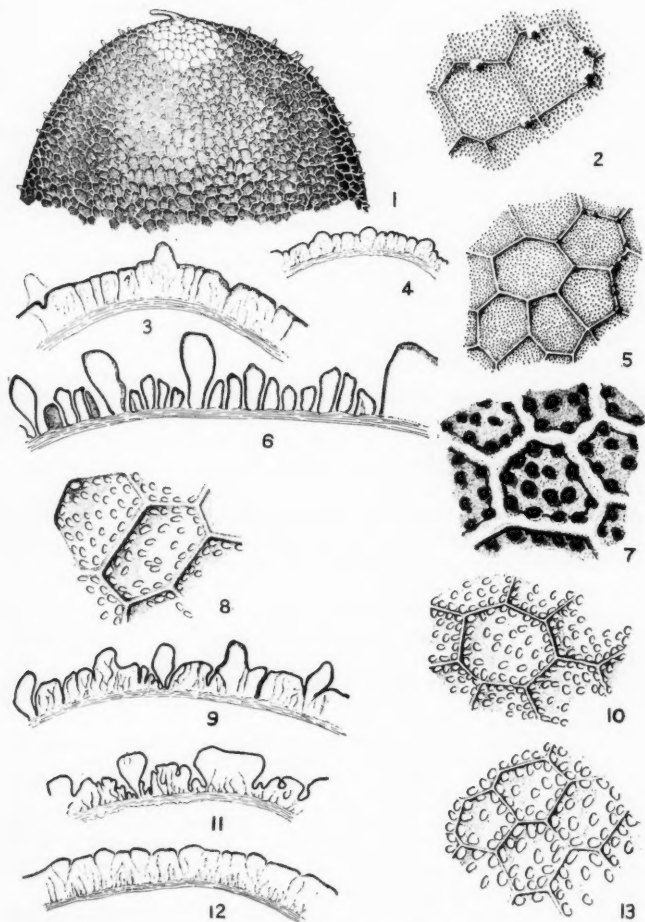
This number, 84 in one case, 113, 108 and 150 in the others, seems to be a fair number of eggs for these forms under laboratory conditions. However, the females seem to do better under laboratory conditions than the males. New males were brought in several times from the field during each of these periods, except in 1939 when the male survived all summer. However, after August 1 all four years no males were taken in the field while the females were to be found in considerable abundance. Whether this means that the males have died off or are out in deeper water is not known.

All females alive in the laboratory and those taken in the field contained eggs on August 20, the last observation. One carried through to Kentucky died September 10 containing 8 well formed ova.

Incubation.—The period of incubation in the field is not definitely known. Eggs kept in the laboratory from July 8 to August 20 showed no signs of development. Those taken in the field August 12 also showed no development.

In 1927 the writer packed eggs deposited in the laboratory and from the field in sphagnum and carried them to her laboratory in Tennessee. They

PLATE III



Figs. 1-13. Egg patterns.—1-3. *N. borealis*; 4, 5. *N. irrorata*; 6, 7. *N. insulata*; 8, 9. *N. indica*; 10, 11. *N. undulata*; 12, 13. *N. lunata*

Date and Number of eggs.

| Female B2 1927 ¹ | | | Female A2 1936 ² | | Female BII 1937 ³ | | | |
|--------------------------------|-----|---------|--------------------------------|-----|---------------------------------|----------|-----|---------|
| Date | No. | removed | Date | No. | removed | Date | No. | removed |
| Jul. 9 | 3 | | Jul. 9 | 10 | | Jul. 14 | 16 | |
| 11 | 5 | | 10 | 24 | | 15 | 24 | |
| 14 | 3 | | 12 | 20 | | 18 | 6 | |
| 15 | 4 | | 16 | 20 | | 17 | 14 | |
| 16 | 6 | | 18 | 16 | | 20 | 2 | |
| 18 | 3 | | 21 | 18 | | 21 | 16 | |
| 21 | 3 | | 31 | 5 | | 22 | 3 | |
| 22 | 1 | | | — | | 24 | 13 | |
| 27 | 3 | | Total 113 | | | | — | |
| 28 | 2 | | | | | Total 94 | | |
| 29 | 2 | | | | | | | |
| Aug. 5 | 22 | | | | | | | |
| 6 | 4 | | | | | | | |
| 7 | 8 | | | | | | | |
| 8 | 3 | | | | | | | |
| 9 | 3 | | | | | | | |
| 10 | 4 | | | | | | | |
| 11 | 5 | | | | | | | |
| | — | | | | | | | |
| Total 84 | | | | | | | | |

¹ Died Aug 12, containing 14 ova. Grand total 98.
² Died Aug 3, containing 10 ova. Grand total, 123.
³ Died Jul 26, containing 14 ova. Grand total, 108.

¹ Died Aug 12, containing 14 ova. Grand total 98.

² Died Aug 3, containing 10 ova. Grand total, 123.

³ Died Jul 26, containing 14 ova. Grand total, 108.

A female which emerged Jun. 27, 1939 deposited first eggs Jul 10, deposited a total of 150 eggs up to Aug 16 and was still living.

were placed in aquaria and set in a window near a radiator. On December 10 eggs deposited July 22 were very dark on the ventral side and showed red eye spots on the dorsal side. They began to hatch December 15. The nymphs appeared weak and were not able to break the surface, and all died after a few hours.

Again in 1936 eggs collected in laboratory and field during July and August were carried through to the author's laboratory in Virginia, divided equally between four aquaria and placed in several locations, began to hatch as follows:

Aquaria 1 and 2 kept on the window ledge where the temperature ran from 70° F. at night to 90° F. during the day, had several eggs showing eye spots on November 24.

Egg No. 1: Showed bright red spots November 24; dark stripes and leg markings December 2; hatched between 1:30 and 3:30 P.M.; nymph swimming vigorously when seen December 3; died December 6.

Egg No. 2: Eye spots November 24; hatched December 4 and took 24 minutes to emerge; molted December 14; second molt December 25; died December 27.

Egg No. 3: Eye spots November 24; started to hatch 10:40 A.M. December 4, and did not get out of the shell.

Most of the material from dish 1 and 2 was not able to emerge from the shell. It would get part way out and die. When they took more than 20 minutes to emerge they were not able to reach the surface and when they did, seemed too weak to feed and move about.

Aquaria 3 and 4 which had been kept at a much cooler temperature, 40° F. to 70° F., began to hatch January 7, 1937 and continued until January 13. Ten eggs hatched between January 30 and February 4; of them, only

one reached maturity; others died between third and fourth instar. Often they did not seem to have the strength to shed the exuviae. Food became difficult to get as drosophila are almost too small for them after the third instar.

Specimen No. 30.—Was the only one to complete its development and had the following history: eggs collected from A2 in the laboratory July 15, 1936; temperature 40° F. to 70° F.; hatched January 30, 1937; first molt February 7; stadium 8 days; second molt February 17, stadium 10 days; third molt March 1, stadium 12 days; fourth molt March 16, stadium 15 days; fifth molt April 6, stadium 21 days; total 66 days from hatching of egg to adult; total of 199 days from laying of egg to hatching; total of 265 days from the deposition of egg to adult; adult died May 6.

Each stadium period was about the same for the other 9 specimens which died before reaching maturity.

Aquarium No. 4 was placed in a spring fed pool October 10 and left out in the open all winter. This material was examined once a week. Since the eggs were deeply embedded no developmental eye spots were noticed but when examined March 20 there were four dead nymphs and again on March 28 there were three dead nymphs, for some reason they were not able to survive the condition. Many others were not able to get out of the egg shell. No eggs hatched after March 28. When the remaining eggs were examined they seemed to be empty or rather watery inside.

Hatching.—For several days before hatching the eyes and dark markings of the legs can be seen through the chorion. From time to time the embryo rotated around in the chorion. One time one eye would be dorsal then lateral then ventral, etc. From general observation the embryo appeared to make about two rotations a day.

When ready to emerge the micropylar end of the egg was divided by five fissures, forming one flap on mid dorsal, one to each dorsolateral and two ventrolateral. The fissure between the ventrolateral was often quite long. As the opening enlarged a thin transparent membrane pushed out, then the head appeared. In some eggs, the nymph emerged dorsal side up, in others ventral side up. The thin membrane broke, the ventral fissure lengthened and the insect gradually wriggled out and dropped to the bottom of the dish upside down, rested about half a minute; wriggled mouthparts up and down; gradually moved legs out from side of body, wriggled up and down in dish; finally came to the surface and rested with dorsal side up. One hour later it was swimming about the dish normally with abdominal hair enclosing air.

The presence of only fifth instar nymphs on June 29 and 30, the absence of nymphs in the field after July 6, the failure of the eggs to hatch in the field and laboratory before August 20, and the incident of hatching under artificial conditions in the laboratory in December, January and February, and in March in the field in Virginia where the weather is much milder seem to leave no doubt that this form winters over in the egg state.

This period of five or six months from the time the egg is deposited until it is hatched does not seem unusual, for some of the English species have about the same habits. Walton (1936) states that *Notonecta maculata* Fabricius eggs have an incubation period of from 4 to 7 months. One female

laid "December 1934 and the eggs hatched in March"; another "laid at the end of August, hatched in March," one case a period of four months and in the other almost 7 months.

At the present time *N. borealis* is the only American species of *Notonecta* which has been investigated that has a range of 4 to 8 months for an incubative period.

DESCRIPTION OF STAGES

THE EGG

Pl. 3, Figs. 1-3

Size.—Length, 1.87 mm. to 2.0 mm.; width, side view, 0.72 to 0.81 mm.; width, top view, 0.54 to 0.62 mm.; chorion thickness 0.07 mm.

Shape.—Elongate oval with a very slight curvature. Slightly smaller at anterior end.

Color and description.—Cream when first deposited, becomes darker with age especially at the micropylar end and along the dorsal surface. The egg is enveloped in a gelatinous envelope which collects debris and must be removed to examine chorion markings. The micropyle is a finger-like projection at the anterior end near the dorsal surface and droops downward. The micropylar end shows a definite sculptural area around the micropyle; this area is made up of many large rather broad nodules placed close together; just back of this the whole anterior end, dorsal and lateral sides of the egg are covered by a definite pattern of smaller prominent pegs arranged along the side and in the corners of the low inconspicuous hexagonal ridges. These nodules become smaller and disappear on the posterior half of the ventral surface of the egg. The function of these nodules is questionable as they appear to be solid chorion similar to the hexagonal ridges; are most abundant on exposed surfaces, and have been found only on *Notonecta* eggs which are inserted in stems.

Walton (1936) mentions similar projections for *N. viridis* Delcourt, *N. obliqua* Gallen and *N. glauca* Linn.; evidently they are not the same as the "l'appareil pneumatique of Poisson (1933)." There is a small area near the micropyle slightly clearer than the rest of the surface made up of broad nodules and without the close set pegs and heavy ridges which are present on the surrounding surface. See Pl. 3, Fig. 1. Poisson mentioned a clear area on the eggs he studied and a clear area near the micropyle is present on all other eggs studied. The pegs and ridges are much more pronounced on the anterior end and dorsal side than on the posterior end and ventral side. The chorion of the whole egg with the exception of the close set nodules and ridges appears very porous.

FIRST INSTAR

Pl. 2, Figs. 4-6 (all instars)

Size.—Length, 2.58 mm.; width of body, 1.32 mm.; width of head, 1.045 mm.; vertex, .385 mm.; synthipsis, 0.85 mm.

Color.—White with a dark dusky line beginning just above each lateral edge of the prothorax back of eye and extending to tip of abdomen. This line becomes a little wider and a little farther from the lateral edge on the abdomen. Last two segments of antennae very dark; tarsal claws black, hairs and spines very dark, hair on hind tarsae may be reddish or light, eyes red; dark line down the middle of the face; frons dark as beak.

Structural peculiarities.—Antennae distinctly three segmented directed toward front of head and downward. The median carina of the abdomen is without distinct hair and is dark; the lateral edge of the sternite margin is well covered with long hair which reaches to the carina area. The middle femora at the base of the caudo-ventral margin one setiferous tubercle. The mesotrochanter has eleven small stout setae on its caudo-ventral margin.

SECOND INSTAR

Size.—See tables 1 and 3.

Color.—White, eyes dark, antennae very dark.

Structural peculiarities.—Ventral abdominal median carina with bare space on fourth segment surrounded by hair, broad, slightly rounded at anterior end. See Pl. 2, Fig. 2. Femora of middle legs with one long setae and two short ones on tubercle.

THIRD INSTAR

Size.—See tables 1 and 3.

Color.—White lateral edge of abdomen beginning to darken on dorsum; eyes darker; legs light with dark markings down middle.

Peculiarities.—Bare space in first section of median abdominal carina broad and long, slightly rounded at anterior end; bare space in second section just appearing; small protuberance appears near subapical end of middle femora; edge of wing pad slightly dark; lateral edge of abdomen dark.

FOURTH INSTAR

Size.—See tables 1 and 3.

Color.—White to greenish on mid-dorsal line, dusky line near lateral margin of wing pad, Lateral edge of abdomen dark; three basal segments have a dark spot which extends one half to two thirds the way up the side; the tip of the abdomen is dark.

Ventral lateral edge of abdomen dark and grows lighter toward hair line; median carina with 2 well developed bare spaces; posterior edge of hind femora dark.

This stage differs little from the fifth instar except in size.

FIFTH INSTAR

Size.—Length, 11.4 mm.; width of body, 5.13 mm.; width of head, 2.85 mm.; vertex, 1.1 mm.; synthlipsis, 0.51 mm.

Color.—In dorsal view, eyes brownish, thorax white with greenish tinge; prothorax with a dusky band near each lateral margin and parallel with it, postero-lateral angle smoky, mesothoracic wing-pad marked with a smoky band on lower lateral edge and part of a band at upper margin. The abdomen is chalky white, usually with no transverse bands. There is a row of black spots on each side which often fuse on the last segment.

In ventral view the head is divided longitudinally by a dark band. The base of the beak and the beak dark; convexum dark; guard hairs dark.

Structural peculiarities.—Ventral view, median abdominal carina long, in three sections, the first is short and broad, rounded at anterior end, surrounded by long hairs, the second about same length as first but narrow, third narrow. Sixth segment of female conspicuously broadened, the sixth ventral abdominal segment of male less than one-half the length of the preceding.

This form is so close in appearance to *N. irrorata* that it is difficult to separate the material; however, after the first instar the shape of the carina appears to be the most constant and best character (See Pl. 1, Figs. 4, 5, 9).

COMPARISON OF NYMPHS

In the study of the life history of the immature stages of *Notonecta* included in this paper it was found that the instars of each species differed enough that one might recognize each species in the field. Hungerford (1920) was able to make a key for the first instars of the four species occurring in New York. For the Michigan, Kentucky and Reelfoot Lake region it has been necessary to add three more species and to make a key for the fifth instar stages. The second, third and fourth instars show characters similar to either the first or fifth instars, therefore, it has not been necessary to make keys for them.

The most difficult forms to distinguish were *N. borealis* from *N. irrorata*, Pl. 1, Figs. 4, 6. *N. undulata* from *N. indica* of Kentucky, and *N. lunata* from *N. raleighi* of Reelfoot Lake, Rice (1942).

A study of tables 1, 2 and Pl. 1, 2 shows *N. irrorata* and *N. borealis* are almost the same size and since they are often found in the same habitat, and pass each instar at about the same time, it is very difficult to distinguish them in the field on the basis of size. However, the first instar is easily recognized,

TABLE 1.—Measurements of *N. borealis*.

| Instars | General Measurements | | | | Hind Leg | | | Middle Leg | | | Fore Leg | | |
|---------|----------------------|-------|------------|--------------|---------------|-------|-------|------------|-------|-------|----------|-------|-------|
| | Length | Width | Width Head | Between Eyes | Synth. Vertex | Femur | Tibia | Tarsus | Femur | Tibia | Tarsus | Femur | Tibia |
| 1st | 2.58 | 1.32 | 1.045 | .385 | .440 | .77 | .715 | .935 | .550 | .440 | .385 | .385 | .335 |
| 2nd | 3.685 | 1.815 | 1.375 | .55 | .495 | .110 | 1.045 | 1.375 | .88 | .715 | .55 | .605 | .605 |
| 3rd | 5.50 | 2.64 | 1.815 | .66 | .55 | .176 | .165 | 1.925 | .110 | 1.156 | .825 | .825 | .88 |
| 4th | 7.64 | 3.85 | .935 | .88 | .935 | 2.53 | 2.475 | 2.47 | .165 | .165 | .110 | .11 | 1.16 |
| 5th | 10.92 | 5.33 | 2.805 | 1.10 | 1.10 | 3.465 | 2.565 | 3.30 | 2.40 | 2.56 | 1.155 | 1.375 | 1.925 |

TABLE 2.—Measurements of *N. irrorata*.

| Instars | Length | Width | Width Head | Between Eyes | Synth. Vertex | Femur | Tibia | Tarsus | Femur | Tibia | Tarsus | Femur | Tibia |
|---------|--------|-------|------------|--------------|---------------|-------|-------|--------|-------|-------|--------|-------|-------|
| 1st | 2.2 | 1.1 | .88 | .330 | .357 | .55 | .605 | .77 | .385 | .33 | .33 | .44 | .275 |
| 2nd | 3.19 | 1.48 | 1.12 | .44 | .55 | 1.10 | 1.045 | 1.155 | .66 | .66 | .55 | .385 | .330 |
| 3rd | 5.335 | 2.31 | 1.65 | .605 | .605 | 1.815 | 1.045 | 1.705 | .99 | 1.10 | .77 | .825 | .715 |
| 4th | 6.765 | 2.935 | 2.035 | .715 | .66 | 2.75 | 2.565 | 2.565 | 1.65 | 1.595 | 1.155 | 1.32 | 1.12 |
| 5th | 11.825 | 5.28 | 2.85 | .825 | 1.375 | 3.575 | 3.30 | 2.86 | .935 | 2.42 | 1.65 | 1.375 | 1.87 |

as *N. irrorata* has the dorsal surface of the whole abdomen very dark while in *N. borealis* the dark or smoky area is confined to the tip and along the lateral sides of the abdomen. If the two forms are placed side by side *N. borealis* will appear slightly larger than *N. irrorata*. Sometimes the first instar of *N. undulata* from certain habitats will show the smoky lateral abdominal lines as seen in *N. borealis* but the general size and shape would show the difference in the two immediately.

A study of table 3 and Pl. 1, Figs. 4-6 shows that the best character for separating the two is the shape and size of the bare spaces on the carina.

N. insulata, Pl. 1, Fig. 1, is very easily distinguished in the third, fourth and fifth instars by the very long bare space on the carina of the fourth abdominal segment and the large number of spines on the middle femur. According to Hungerford (1920), it may be distinguished in the first instar by 10 or 11 stout spines on margin of hind femur.

N. lunata, Pl. 1, Fig. 2, may be very easily recognized in the field by the light and dark bars on the legs during the first and second instars; and by the very bright red eyes and angulated meso-trochanter in the other three instars.

N. undulata, Pl. 1, Fig. 3, is very easily distinguished from the other Michigan species by its size; lack of dark and light bars on the legs of the first and second instars and by the very short bare space on the first segment of the median abdominal carina. This space is not as bare in this species as in the other species mentioned, as it is covered by very short hair which is more dense than in other species.

TABLE 3.—Comparison of carina of *N. borealis* and *N. irrorata*.

| Instar | | Carina of <i>N. borealis</i> | Carina of <i>N. irrorata</i> |
|--------|--|----------------------------------|-----------------------------------|
| 1st | Comment | No carina present | No carina present |
| 2nd | Length | .275 mm. | .33 mm. |
| | Anterior width | .110 mm. | .165 mm. |
| | Caudal width | .0385 mm. | .055 mm. |
| | No. of sec. | 1 | 1 |
| | Comment | Slightly rounded at anterior end | Slightly truncate at anterior end |
| 3rd | Length | .385 mm. | .55 mm. |
| | Anterior width | .165 mm. | .275 mm. |
| | Caudal width | .110 mm. | .12 mm. |
| | No. of sec. | 2 | 1 beginning second |
| | Comment | Slightly rounded at anterior end | Appears truncate at anterior end |
| 4th | Length | .715 mm. | .825 mm. |
| | Anterior width | .165 mm. | .275 mm. |
| | Caudal width | .11 mm. | |
| | No. of sec. | 2 and part of 3rd | 2 beginning of 3 |
| | Comment | Rounded at anterior end | Truncate at anterior end |
| 5th | Length | 1.04 mm. | 1.54 mm. |
| | Anterior width | .165 mm. | .275 mm. |
| | Caudal width | .11 mm. | .0165 mm. |
| | No. of sec. | 3 well developed | 3 well developed |
| | Comment—The carina is the best character for separating these two species. | | |

The immature stages of *N. undulata* are very difficult to distinguish from *N. indica* which is found in Kentucky where the range of the two overlap. From the time they hatch until they emerge as adults the measurements, the carina structures and setae are all very similar. The most striking difference in the first instar of *N. indica* is the light space just behind the very black tarsal claws which appears as a light band in the living specimen and the body of *N. indica* has a much more chunky appearance when compared with the *N. undulata* nymph. The fifth instar can be distinguished by appearance of the head. The dorsal view of the head of *N. indica* appears longer than wide due to the almost straight interocular space at the vertex, which is almost on a level with the anterior margin of the eye; the anterior margin of the eye continues straight for a very short distance then drops off rapidly on the lateral edge; while in *N. undulata* the effect is globular due to the gradual curvature of the vertex, anterior and lateral margin of the eye; this causes the greatest width of the eye to appear at a different point from that seen in *N. indica*, Rice (1942), Pl. 2, Figs. 2-3. These differences are also noticeable in all the other instars.

KEY TO THE FIRST INSTAR NYMPHS OF SOME SPECIES

- A. Color dark, smoky testaceous posterior margin of middle femora with long setae on tubercle.
 - B. Smoky line very wide on thorax and band may cover all of segments of abdomen, 7 long setae on middle meso-trochanter; 2 to 2.6 mm length*N. irrorata*
 - BB. Smoky line narrow on thorax, extends along lateral sides of abdomen, no smoky band on basal segment of abdomen, 11 setae on meso-trochanter; 2.5 to 2.8 mm. length, slightly larger species*N. borealis*
- AA. Color light. Posterior margin of middle femur with 2 setae on tubercle:s.
 - B. Length 2.6 mm. or more. Posterior margin of hind femur with 10 to 11 stout setae, plus 2 longer ones at distal end*N. insulata*
 - BB. Length, less than 2.6 mm. Posterior margin of hind femur with 7 or 8 short setae, plus 2 longer ones at distal end.
 - c. Legs conspicuously banded.
 - D. Legs with several bands: setae on posterior margin of hind femur not conspicuous; margin of abdomen narrow; slender body*N. lunata*
 - DD. Legs with one band just behind tarsal claw; setae conspicuous; margin of abdomen wide, plump body*N. indica*
 - CC. Legs not conspicuously banded. Setae on posterior margin of hind femur conspicuous. Margin of abdomen wide, robust nymphs*N. undulata*

A KEY TO THE FIFTH INSTAR NOTONECTA NYMPHS OF EASTERN U. S.

- A. Less than 9 mm. in length. Ventral abdominal carina with bare portion slender, sparsely covered with short or long hair.
 - B. Dark form; meso-trochanter broad at base, slightly angulate. First section of carina large, sparsely covered with short hair, second and third narrow but distinct*N. uhleri*
 - BB. Light form; few narrow dark bars across first and second abdominal segments; meso-trochanter rounded or angulate. Anterior section of abdominal carina extremely narrow, covered with short hair, second and third sections not always distinct.
 - c. Meso-trochanter rounded.
 - D. Anterior outline of head as seen from above somewhat rounded*N. undulata*
 - DD. Anterior outline of head as seen from above somewhat straight, sloping abruptly to lateral edge*N. indica*

- CC. Meso-trochanter angulate, anterior section of carina sparsely covered with short hair.
 D. Size medium 7 to 7.5 mm.; four or more setae on fore femur*N. lunata*
 DD. Size small 5.5 to 6.5 mm., fore femur with three distinct setae*N. raleighi*
 AA. More than 9 mm. in length, ventral abdominal carina divided into three distinct sections.
 B. Ventral abdominal carina with mid portion of first two sections bare, the third closed; anterior section almost three times as long as second, mid femur with seven setae*N. insulata*
 BB. Ventral abdominal carina with mid portion of all three sections bare, anterior section as long or slightly longer than the second section.
 C. Anterior bare section of abdominal carina large slender and rounded at anterior end about as long as the second. Sixth abdominal segment of female produced to a broad point in the middle. Sixth segment of male less than one-half as long as preceding segment*N. borealis*
 CC. Anterior bare section of abdominal carina long not so slender, slightly longer than the second and truncate at the anterior end. Sixth abdominal segment of female produced to a narrow point in the middle. Sixth segment of male more than one-half as long as the preceding*N. irrorata*

HATCHING AND DEVELOPMENTAL RECORDS

The two charts of development through the fifth stadium given in table 4 show that under laboratory conditions the total number of days required to pass the five stadia in a small sample of two species require almost the same time, 45.4 days for *N. lunata* and 44 days for *N. undulata*. This record should be similar to that found in the field. Food and temperature are big factors in controlling survival and rate of growth of these species.

The small size of the samples is due to the high death rate and the failure of some nymphs to have reached the fifth instar by August 28 and were not included in this record.

All laboratory records show that an average of 52 to 72 days are needed to pass the complete life cycle of all Michigan *Notonecta* except *N. borealis* which requires 199 to 265 from laying the egg to an adult.

DISCUSSIONS OF EGGS AND EGG PATTERNS

Larsen (1930) in his work on *Notonecta* of Sweden states that it is possible to identify species of *Notonecta* eggs by the engraved pattern on the surface of the chorion in addition to the difference in size and general structure of the egg. He diagrams a small section of the chorion of *N. maculata* and *N. glauca* which show considerable difference in the markings. However, he says nothing about any other structures on these eggs except the micropyle. Walton (1936) pictures the cross section of the chorion of four English species and they all have characteristic differences. Poisson (1933) made a very detailed study of the structure of some of the hemipteran eggs in which he shows the elaborate sculpturing and structure of the chorion and includes one *Notonecta*.

At present the chorion of the egg of eight species of American *Notonecta*, four species of *Buenoa* and *Plea striola* have been studied by the author and found to have a definite sculptural pattern. Therefore it is possible to identify the notonectoid species by the chorion pattern as well as by the size and shape of the egg.

The notonectoid eggs may be divided into two groups, those inserted in

TABLE 4.—Hatching and development records.
N. lunata

| Specimen No. | Egg Laid | Hatched | Days Required | 1st Molt | Days Required | 2nd Molt | Days Required | 3rd Molt | Days Required | 4th Molt | Days Required | 5th Molt | Days Required |
|-----------------|----------|---------|---------------|----------|---------------|----------|---------------|----------|---------------|----------|---------------|----------|---------------|
| 3D ¹ | 7/4 | 7/10 | 6 | 7/15 | 5 | 7/22 | 7 | 7/31 | 9 | 8/13 | 13 | 8/26 | 13 |
| 3D ² | 7/7 | 7/14 | 7 | 7/19 | 5 | 7/25 | 6 | 8/1 | 7 | 8/14 | 13 | 8/27 | 14 |
| 2D ¹ | 7/6 | 7/14 | 8 | 7/20 | 6 | 7/27 | 7 | 8/3 | 6 | 8/13 | 10 | 8/24 | 11 |
| 2D ² | 7/6 | 7/15 | 9 | 7/22 | 7 | 7/30 | 8 | 8/6 | 6 | 8/16 | 10 | 8/27 | 11 |
| 3D ⁶ | 7/4 | 7/11 | 7 | 7/18 | 7 | 7/25 | 7 | 8/4 | 10 | 8/15 | 11 | 8/28 | 13 |
| 3D ⁷ | 7/4 | 7/11 | 7 | 7/17 | 6 | 7/26 | 8 | 8/6 | 10 | 8/16 | 10 | 8/29 | 13 |
| 3D ⁸ | 7/4 | 7/12 | 8 | 7/19 | 7 | 7/29 | 10 | 8/8 | 10 | 8/19 | 11 | 8/29 | 10 |
| Average | | | 6.4 | | 6.1 | | 7.4 | | 8.3 | | 11.1 | | 12.3 |

Total days for complete development—51.8.

Total days to complete five stadia—45.4.

N. undulata

| | | | | | | | | | | | | | |
|----------------|-----|------|---|------|-----|------|---|-----|---|------|---|------|------|
| U ¹ | 7/8 | 7/16 | 8 | 7/23 | 7 | 7/30 | 7 | 8/5 | 6 | 8/13 | 8 | 8/27 | 14 |
| U ² | 7/8 | 7/17 | 9 | 7/25 | 8 | 7/31 | 6 | 8/8 | 8 | 8/16 | 8 | 8/28 | 12 |
| U ³ | 7/8 | 7/15 | 7 | 7/23 | 8 | 7/31 | 8 | 8/6 | 6 | 8/14 | 8 | 8/28 | 14 |
| Average | | | 8 | | 7.9 | | 7 | | 8 | | 8 | | 13.1 |

Total days for complete development—52.

Total days to complete five stadia—44.

stems and those placed on the surface of stems. Of those eggs inserted in stems *N. borealis* has the largest and *Plea striola* the smallest. All of the *Buenoa* insert their small eggs into a stem in such a manner that a small cap-like structure on the cephalic half of the egg remains exposed. One layer of this cap is on a level with the surface of the stem and often peels off when the egg is removed from the stem.

The pattern of *N. borealis* was discussed under the biology of that species. This egg, Pl. 3, Fig. 3, in cross section is very thick and tough; the reticular ridges scarcely stand above the perforation bars; here and there usually at the corner of a hexagonal reticulation a solid nodule, either single or double, rises some distance above the surface of the reticulation. This egg is very easily distinguished from the *N. irrorata* egg by the very prominent nodules, low reticular ridges, thick chorion and peculiar structures around the micropyle. See Pl. 3, Figs. 2, 3, 4, 5.

The egg of *N. irrorata* when newly-laid (length, 1.51 mm.; diameter .572 mm.), is white to cream in color. The micropylar area becomes very dark but does not have the conspicuous hexagonal region above it as in *N. borealis*. This egg may be inserted completely or only partially into the stem.

The reticular pattern of this egg is very distinct. Pl. 3, Fig. 5. The ridges are high and broad; the perforations are medium; thickness of chorion medium; nodules very small and inconspicuous; always in the corner of the reticulation.

The nodules found on these two eggs are also shown by Walton (1939) for four of his English species of *Notonecta*. So far they have only been found on *Notonecta* eggs which are inserted into stems.

Hungerford (1920) pictures the small *Plea* egg and shows definite hexagonal reticulations. This is the smallest egg examined; length .598 mm.; diameter .234 mm. This egg may be inserted completely into the stem, with only a slit showing where it has entered, or a small section of the top surface of the egg may remain exposed. No cross section of this egg was successful. The perforations are very fine.

The *Buenoa* eggs are all very similar in size and general appearance. The reticular cap-like structure of all four species rests on the surface of the stem; this usually appears very dark unless newly-laid.

The egg of *B. margaritacea* was described by Hungerford (1920) as elongate oval when seen from above. In lateral view it appears almost straight in outline of its upper surface, while the lower surface is quite strongly curved. The surface appears reticulate under magnification.

Length 1.125 mm., by 0.406 mm. in its widest diameter, the cap extends more than one-half the length of the egg. This egg appears more slender than that of *B. limnocastoris*. The micropyle is long and curved downward just beneath the cap on the cephalic end of the egg. During development this egg does not become as creamy or show as many red globules as do the other species.

B. limnocastoris has a rather large plump egg; length 1.21 to 1.3 mm.; lateral diameter 0.45 mm.; creamy white in appearance when first laid and remains so until red globules form during the development. Prominent reticu-

lations are present on the cap and dorsal surface, less prominent over lateral surface. The chorion of this egg does not become clear with age as does the other species but remains cloudy or milky white in appearance. The cap does not reach one-half the dorsal length of the egg. Pl. 2, Fig. 7.

B. macrotibialis has the most slender and longest egg of all the *Buenoa* species. Length 1.3 to 1.4 mm.; lateral width 0.43 mm. The cap extends more than one-half the length of the egg. The reticulations are strong on the cap but appear as pressure indentations over the rest of the surface. The chorion is clear and glassy in appearance. This egg resembles the egg of *B. elegans* more than it does the other two species. P. 2, Fig. 8.

B. elegans has the smallest egg of any of the *Buenoa* studied; length 1.05 mm. to 1.1 mm.; width 0.40 mm. This egg is rather slender; reticulation very prominent on cap and tip end of egg but very indistinct over the surface; chorion very clear and cytoplasm recedes leaving a clear area at tip; micropyle is prominent; red globules appear with age; cap one-half length of egg. Pl. 2, Fig. 9.

Of the eggs placed on the surface of stems *N. insulata* is the largest: 2.21 mm. in length; and 0.78 mm. in diameter. The surface of this egg is rough; the hexagonal ridges are high and broad; the respiratory perforations are large, and in view the areas between the pores appear far apart. This egg could never be mistaken for that of the other three species.

N. lunata, Pls. 2, 3, Figs. 13, 12, 13, length 1.69 to 1.7 mm., diameter side view 0.78 mm. This egg also has a rough surface; the hexagonal reticulations are thin, the bars separating the perforations are the same height as the ridges, therefore the general appearance is very rough. This rough appearance easily separates the egg of this species from the other species. The perforations are fewer but larger than those in the next species. A clear area is present around the micropyle as in most *Notonecta*.

N. undulata, Pl. 3, Figs. 10, 11; length 1.62 to 1.8 mm.; diameter 0.5 to 0.6 mm. The hexagonal reticulations on the chorion of this egg are distinct. The bars separating the perforations are of three heights, as a result the general pattern is more distinct than that of *N. lunata*.

A KEY TO EGGS OF THE NOTONECTIDAE AND PLEIDAE OF THE DOUGLAS LAKE REGION

A. Eggs inserted in stems.

B. Eggs without a dorsal cap.

c. Eggs very small, 0.598 to 0.6 mm., prominent reticulations over surface *Plea striolata*

cc. Eggs large, 1.5 to 2.0 mm.

d. Eggs 1.8 to 2.0 mm., prominent nodules over the dorsal and lateral surface; peculiar broad nodules near micropyle; reticulations indistinct *N. borealis*

dd. Eggs 1.5 to 1.8 mm. Prominent reticulations over entire surface, nodules inconspicuous; no broad nodules near the micropyle *N. irrorata*

BB. Eggs with a dorsal cap.

c. Plump eggs with pearly white to greyish chorion; reticulations over entire surface distinct.

d. Cap extends slightly more than one-half dorsal length of egg; eggs 1.1 to 1.2 mm. long *B. margaritacea*

- ED. Cap does not reach one-half dorsal length, lateral width slightly greater; eggs 1.1 to 1.2 mm. long *B. limnocastoris*
- CC. Slender eggs; chorion clear and glossy.
 D. Small, 1.05 to 1.09 mm., cap one-half total length of egg; reticulations on and around cap distinct *B. elegans*
- DD. Large, 1.3 to 1.4 mm., cap extends more than one-half the length of the egg; reticulations distinct on cap appears as pressure indentations on egg *B. macrotibialis*
- AA. Eggs not inserted in stems.
 B. Eggs large, 2.21 mm.; reticulations very prominent; reticular ridges high, perforation ridges low; perforations large *N. insulata*
- BB. Eggs medium, 1.6 to 1.8 mm.; reticulations prominent.
 C. Reticular ridges rough, perforations medium.
 D. Reticular ridges very rough; bars between perforations as high as ridges. See cross section Pl. 3, Figs. 12, 13 *N. lunata*
- DD. Reticular ridges rather thin; perforation bars not as high as reticular ridges *N. undulata*

SUMMARY OF NOTONECTID EGGS

All eggs of *Notonecta* examined which are inserted in stems both in America and Europe have characteristic nodules in addition to the regular hexagonal ridges.

All *Buenoa* eggs examined so far have distinct reticular caps and less distinct hexagonal reticulations over the body surface.

Plea striola has the smallest egg seen so far by the author. This egg has the characteristic hexagonal reticulations and respiratory perforations of all *Notonectidae* eggs.

All of the eggs placed on the surface stems have the characteristic reticulation pattern differing only in thickness of chorion height and size of ridges. The differences in the structure and size of the *Notonectidae* eggs examined are distinct enough to use as characters for distinguishing the different species. Therefore, the preceding key has been made for the species studied.

PLEA STRIOLA Fieber

Very little has been written about this the smallest of the American backswimmer beyond the general biology and a description of the egg by Hungerford (1920), and a short note on life history by Bare (1926). The writer became interested in this form because of the undeveloped hind wings and made the following observation while attempting to rear them.

In the Michigan region *Plea* has been collected abundantly from two habitats: two slow running streams (Fontinalis Run and Maple River), and from Sedge Pool, a large pool formed by a sand bar being thrown up on the north side of Douglas Lake. The factor in common in these two stations is the presence of *Chara*. What the effect of *Chara* has upon these insects is not known. When taken from this habitat the old ones seem to survive nicely; the eggs hatch readily and the young do well in the laboratory.

A group of old *Plea*, carried from Michigan to the author's laboratory in Virginia during the winter were placed in a balanced aquarium. A new generation began to hatch the first week of April 1938 and some of these were in the fifth instar June 26, 1938 and were full adults by August 20, 1938. No second generation was produced from these. All of this checks very

nicely with field observations. On June 28, 1938 between 50 and 75 adults and fifth instar nymphs were collected in Sedge Pool. The first eggs were found the 26th of July and one or two first instar nymphs were seen August 8. Again in 1939 a female brought in July 6 deposited eggs the same day and continued to do so all summer.

Field observations.—Hussey (1919) states that this form was very uncommon in the submergent vegetation during July. During 1936 and 1937 great numbers of adults and young were taken from June 26 to August 17 in the field and these collections compared favorably with laboratory observations. The first young seen in both laboratory and field was July 9.

Mating and oviposition.—Mating as described for *Plea minutissima* Leach takes place frequently and over long periods.

Whether or not the following observations is true for all oviposition of *Plea* has not been checked, but was observed twice for this pair Pa¹ at two different observations and again in 1939 for three other pairs.

The female Pa¹ with the small male perched upon the curved portion of her back with his legs spread out over the hemelytra and his beak resting gently in the suture at the base of the scutellum, began to wander back and forth along a small stem of grass which was submerged parallel with the bottom of the dish, testing it with her ovipositor. Finally she swung to the side of the stem, got a good grasp with her legs and beak and began to scrape the plant tissue away. The ovipositor was pushed its full length each time. After the surface of the stem was broken through she backed up about one-half the length of her body and continued to scrape, when the groove was long and deep enough she stopped and began to push the egg down into the groove. At this point the male stroked her sides with his hind feet. This procedure of placing the egg in the groove required about one minute. As soon as the egg was pushed into the groove she raised the tip of her abdomen and scraped the ovipositor for 3 or 4 minutes with her hind legs; then moved about for 2 or 3 minutes, turned around opposite to the last position and went through the same procedure. She laid 4 eggs in 30 minutes and each time she faced in the opposite position to the last and the eggs were put down in a straight line. While this procedure was going on large gas bubbles collected on the ventral surface and were released to the surface from time to time. At the end of one hour she had laid 6 eggs and had not been to the surface for air. At the end of the 6th egg the male left her back to catch some food and the female after rubbing her ovipositor for a short time also left the stem to chase food. This female laid 10 more eggs before morning, whether the procedure was the same each time is not known. One week later she was seen to be laying again and as was the case the first time the male was perched on the middle of her back.

The egg was usually so well embedded in the stem that only the slit where it had been inserted was visible.

THE EGG

Size.—Length, .598 mm.; diameter, .234 mm.

Color.—Very pale greenish.

Shape.—Elongate, oval, but not regular. Viewed laterally the top line is nearly straight, while the lower line is curved. The anterior pole is flattened on the side bearing

the micropyle, which is a slightly curved, cylindrical peg. The surface appears reticulated with irregular hexagons when seen under compound microscope.

Incubation.—Under laboratory conditions with temperatures ranging from 55 to 80, the eggs hatched in from 8 to 21 days. The first stadium required 7 days, second stadium—8 days, third stadium—11 days, fourth stadium—14 days, fifth stadium—16 days—a total of 56 days from time of hatching to the adult stage. Bare's record from Kansas was 20 to 21 days.

Thus the total development requires 64 to 77 days here as well as in Kansas. There is no evidence of a second generation.

Bare (1926) spoke of some of his forms disappearing from their containers, for some unknown reason some of the old specimens have tried to escape from my balanced aquaria by crawling up the sides. If they do not get out they stay on the sides until they die.

BUENOA MACROTIBIALIS Hungerford

Observations.—There are four species of *Buenoa* in the Douglas Lake region. The large *Buenoa macrotibialis* has always been associated with *B. elegans* in the deep bog pools until this year when it was found in great numbers associated with the large *B. margaritacea* in a shallow roadside marl pool. It was found in this habitat so late in the season that no nymphal instars were taken. Whether or not this form has more than one generation a year in this region is not known.

No fifth instar nymphs have ever been taken of this form. Whether the adult lives over the winter or not is still a question. Some of the eggs certainly carry over the winter and hatch the next spring. Whereas some laid in the laboratory 7/17 hatched 8/7, 8/8 and 8/9; others showed no eye spots on 8/19 but were live eggs. In 1937 eggs taken to the author's laboratory in Virginia hatched from March 3, 1938 to March 20, 1938; this would indicate that the majority of this form winter over in the egg stage.

The most interesting thing about this observation is the ability of some eggs to hatch with an incubation period of 21 days to 7 months. Walton (1936) reported a variation of 4 to 7 months in *N. maculata*. Also a similar condition was observed in the case of *B. limnocastoris* in 1938 and 1939.

BUENOA LIMNOCASTORIS Hungerford

This is one of the three large *Buenoa* found in the region of the Biological Station and nothing is known about its life history. It is still in the nymphal form when the Station opens the latter part of June.

The first specimens in 1937 were taken in Sedge Pool July 1 and out of 15 specimens all except 2 were in the fifth instar. All except 2 males lived only a few days in the laboratory. The same was true June 23, 1949.

Another collection was made July 13. At this time all were in the adult stage. A number of males and females were collected in shallow water around fallen bulrush and placed in an aquarium. About an hour later two or three eggs were noticed on the bottom of the dish. A piece of bulrush was placed in the aquarium and on July 14 several eggs had been placed in the stem. Most of them were hidden except a brownish cap which rested on the surface of the stem. This group continued to lay eggs for several days. As members died off they were replaced by new collections and 2 females lived until September 20 when they were accidentally killed.

A visit was made to the field August 17 and no adult or nymphs were seen, but when pieces of floating water-soaked bulrush were examined they were found to contain *Buenoa* eggs. These eggs were no further advanced in development than those which had been kept in the laboratory since July 14.

When eggs laid on July 14 were examined on July 15 they showed reddish pigment globules on the ventral side. Several days later these red globules were scattered over the entire cytoplasm of the egg. On August 8, some of the same eggs showed eye spots. These eggs hatched the middle of September. The others did not hatch until March.

In 1939 all stages of development from the first to the fifth instar were found in the field July 1. No young were observed on August 3, but females were still abundant in the field and laying eggs.

Old water-soaked rush stems were examined for eggs. Every stem picked up had from 50 to 150 eggs in it, and there were thousands of these stems lying about in the shallow water and on the bare ground from which the water had receded. Many eggs had already dried up. As the water continued to recede, it is a known fact that millions of these eggs perished. However, from the examination of dried stem it was found that about 1 egg out of 10 was still alive, and since these stems are very spongy it may be possible that with frequent showers a few of these eggs will survive.

Preoviposition, and hatching.—A fifth instar nymph emerged in the laboratory July 5; was placed with a male on July 12; was mating within one-half hour; laid first eggs July 17. Five of these eggs hatched July 31 and the other eggs still showed no development but were still alive. Of hundreds of eggs brought in from the field August 3 none showed eye spots, and still showed no eye spots on August 20.

FIRST INSTAR

Size.—Length 1.42 mm.; body width 0.44 mm.; width of head 0.42 mm.; width between the eyes 0.11 mm.

Color.—Eyes red and extremely large; body very dark, brown to black; deep black line along side of thorax; oxi-haemoglobin present.

SECOND INSTAR

Size.—Length 2.8 mm.; body width 0.935 mm.; width of head 0.715 mm.

Color.—Black streak extends from head to abdomen along side of thorax; black spot each side of abdomen.

THIRD INSTAR

Size.—Body length 3.57 mm.; body width 1.21 mm.; head width 0.715 mm.

Color.—Black streak through lateral edge of pronotum and wing pad; side of abdomen segments four, five and one-half of six black on sides, top light; pronotum slightly raised.

FOURTH INSTAR

Size.—Length 3.96 mm.; body width 1.32 mm.; width of head 1.04 mm.

Color.—Same as in third instar.

FIFTH INSTAR.—See table 5

BUENOA ELEGANS (Fieber)

Much has been written about *B. elegans* for other regions. This is the smallest *Buenoa* found in this region, along with *B. limnocastoris* it is the most abundant. It seems to prefer the deep bog pools and is often associated with *B. limnocastoris* in these habitats. From field collections and laboratory

rearings, this form may have more than one generation. Some females collected in the field lay eggs, some do not. Some of the eggs hatch within 20 days, others take five to six months. Many third, fourth and fifth instar nymphs and a few adults were taken in the middle of June. By July 15, the adults were abundant and nymphs were scarce. On August 1, a collection showed a few nymphs ranging from the second instar to the fifth. The adults were fewer in number than earlier in the summer and of 20 females brought in only two were laying eggs. Whether any of these females winter over is not known.

No complete life history has been run. First and second instars have been run from nymphs collected in the laboratory and the later instars from the field collections. From the time it takes to complete each instar the total period appears to be 45 to 55 days in the laboratory, and there seems to be both summer and winter eggs as some hatch in 20 days and others in five to six months.

Preoviposition period.—One female emerged in the laboratory August 8, 1938 and laid four eggs on August 19, making eleven days between emergence and first eggs.

See the next section for comparison of fifth instar nymphs.

BUENOA MARGARITACEA Torre-Bueno

This form was reported for Michigan in August 1939 for the first time by Miss Isabelle Baird. It was taken along with *B. macrotibialis* in two pools formed by a road passing through a grass marsh. *Chara* made up the chief vegetation in these pools. At the first visit, August 3, hundreds of both nymphs and adults of *B. margaritacea* were present in both pools. On August 12 eight days later the north pool was practically dry and all insect life was practically gone. Fifty to sixty sandpipers were feeding in this pool. Only 2 *B. macrotibialis* were taken in this pool. *B. margaritacea* was concentrated in the south pool. Many first instar nymphs were present. Eggs taken in the field on August 3 were hatching by August 12 in the laboratory. Whether adults or eggs winter over here is not known. Farther south in Kentucky and Kansas they winter over in the adult stage.

Bare (1926) states that it takes 52 to 72 days for them to complete their life history in Kansas. Whether the very young will be able to complete their life cycle is a question. No nymphs have been taken in Kentucky after the first ice has formed. The adults have been brought up with mud from the bottoms of ponds all winter. The first adults appeared there in the first week of April.

TABLE 5.—Comparison of size of fifth instar of three *Buenoa*

| | <i>B. elegans</i> | <i>B. limnocastoris</i> | <i>B. margaritacea</i> |
|------------------------------------|-------------------|-------------------------|------------------------|
| Body length | 4.0 mm. | 5.44 mm. | 6.05 mm. |
| Body width | 1.54 mm. | 1.92 mm. | 2.4 mm. |
| Head width | 1.10 mm. | 1.15 mm. | 1.34 mm. |
| Width between the eyes | 0.2 mm. | 0.275 mm. | 0.38 mm. |
| Length of sixth ventral segment | 0.55 mm. | 0.6 mm. | 0.71 mm. |
| Comment | small, slender | raised pronotum | plump, head short |

SUMMARY

All of the ten notonectoid species found in the Douglas Lake, Michigan, region have five instars. *N. borealis* passes the winter in the egg stage, *N. irrorata*, *N. insulata*, *N. undulata*, *N. lunata*, probably winter over as adults. *B. elegans* and *B. margaritacea* may possibly winter over as adults as well as by eggs as both summer and winter eggs were produced and farther south females are found all winter. *B. limnocastoris* and *B. macrotibialis* probably winter over in the egg stage only, as no eggs laid in the laboratory hatched before mid winter or early spring.

It was possible to identify nymphs of all species in the field and laboratory. All eggs were found to have distinct chorion patterns.

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A Systematic Study of the North American Lizards of the Genus *Ophisaurus*

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For the past half century the glass lizards of North America have generally been considered to represent a single, wide ranging, highly variable species. Prior to the twentieth century there had been several attempts to recognize more than one form of North American *Ophisaurus*, but none of the several names proposed attained wide recognition. Nearly all published references now discuss only *Ophisaurus ventralis*. Smith (1946) mentioned that, "there are indications that several races may be recognizable," but aside from this and similar casual remarks, interest in the taxonomy of *Ophisaurus* has been lacking among modern herpetologists until quite recently. Neill (1948) reestablished the subspecies *Ophisaurus ventralis compressus* of Cope, and in a subsequent paper (1949) called attention to a second species of glass lizard to which he applied the name *Ophisaurus attenuatus* Baird. These two papers of Neill's, based on small numbers of specimens from southeastern United States, shed new light on the fact that the taxonomy of the North American *Ophisaurus* was not a closed matter, and made obvious the desirability of a study which would include all the available specimens from the entire range of the genus on this continent. At the suggestion of several members of the Department of Biology of the University of Florida, I undertook such a project in the spring of 1950.

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This study has been conducted from beginning to end under the guidance of Dr. James A. Oliver, for whose excellent advice and aid I am most sincerely grateful.

METHODS

A list of the characters used in my investigation is given below, with definitions and/or explanations.

Snout-vent length: the distance from the tip of the snout to the anterior margin of the anus.

Tail length: the distance from the anterior margin of the anus to the tip of the tail. The amounts of original tail and regenerated tail were recorded separately.

Head length: the distance from the tip of the snout to the posterior margin of the ear opening.

Head width: the distance across the head taken at the level of the posterior edge of the eye.

Eye diameter: the greatest longitudinal diameter of the eye.

Dorsal scale rows: the number of longitudinal scale rows counted transversely across the back from the lateral fold on one side to the lateral fold on the opposite side. The several rows of small, more or less granular scales in the lateral grooves were not counted as dorsal rows, but sometimes doubt arose as to whether a row of scales at the edge of the lateral fold was of sufficient prominence to be considered a dorsal row. In such cases, if the row in question was more than half as large as the adjacent dorsal row, it was considered to be one of the longitudinal series of dorsal scales.

Scales along lateral fold: the number of transverse series of dorsal scales, counted along the second dorsal scale row above the lateral fold, in the distance between points lying just above the anterior and posterior extremes of the lateral fold. This count was taken on the left side only.

Scales around tail: the number of rows of scales around the base of the tail, counted at a point five subcaudals distant from the anus.

Scales around parietals: the number of scales touching each parietal plate.

Upper labials: the number of scales bordering the upper margin of the mouth, counted posteriorly through the scale above the posterior end of the mouth opening.

Lower labials: the number of scales bordering the lower margin of the mouth counted posteriorly through the scale directly below the posterior margin of the eye.

Preoculars: any scale below the canthal row, in contact with the orbit, but not in contact with the upper labials.

Lorilabials: any scale in contact with both the suboculars and the upper labials. (As used here, suboculars are small scales occurring just below the orbit, whereas lorilabials are distinct plates, separated from the orbit by the suboculars.)

Loreals: any scale on the side of the head in the area bounded by the canthals dorsally, the postnasals anteriorly, the preoculars and lorilabials posteriorly, and the upper labials ventrally.

Postnasals: any scale touching the nasal scale on its posterior half, at the same time being between the supranasal and the second upper labial (the latter being in contact with the nasal).

Labials entering orbit: the number of upper labials that are in contact with the orbit.

Frontonasals: the scale or scales in the median line between the postrostral and the frontal (or between the postrostral and the prefrontals if the prefrontals are in contact medially).

Separation of the prefrontals: whether the prefrontals are in contact in the median line, or are separated by a posterior extension of the frontonasal.

Contact of the uppermost postnasal: whether the uppermost postnasal is in contact with the supercanthal row of scales. In both this and the preceding character specimens occur which have the pertinent scales in contact only at a point, or separated by a hair-line, as the case may be. In such instances, it is often impossible to decide definitely whether the contact in question does or does not occur. Therefore, specimens that presented this difficulty were recorded in a separate category, "contact questionable," and are so listed in the tables.

All measurements are in millimeters. Measurements of the head were taken with vernier calipers; snout-vent length and tail length were taken on a millimeter rule. Measurements of the head were made on the left side only.

Sex was determined by examination of the gonads. I was usually unable to sex specimens under 100 mm. snout-vent length. Therefore, since all characters were first analyzed separately according to sex, I set 100 mm. snout-vent length as the lower size limit for inclusion in the tabulations. Where no sexual dimorphism was observed, the data for the two sexes were combined.

Standard biometrical procedures as given in Simpson and Roe (1939) were used in this study. The following abbreviations are used in the tables: M—arithmetic mean, σ standard deviation, V—coefficient of variation, O.R.—observed range, N—number of specimens in the sample. The numbers separated by a " \pm " symbol from M, σ or V are the standard errors of those statistics. The term "significant" is used throughout this paper in a statistical sense only. The lower limit of significance is taken to be a "t" value of 3 or more, or a "P" value of .003 or less. The calculation of "t" and "P" is explained in Simpson and Roe (*supra cit.*), and the reader is referred to that volume for a discussion of the method involved.

The figures given in parentheses in the color descriptions refer to the *Colour Atlas* of Villalobos and Villalobos (1947), which has been used as a color standard throughout this investigation. References to the *Colour Atlas* are given only in descriptions of individual specimens. It was felt that the very precise terminology of the *Atlas* was not applicable when an entire species or group of lizards was under discussion.

For convenience in discussing the color patterns, the dorsal scale rows (longitudinal) were numbered from the midline to the lateral fold. Thus, if a specimen has fourteen dorsal scale rows, the uppermost dorsal row of each side would be "row one" and the row next to the lateral fold of each side would be "row seven." Similarly, the ventral scales were numbered from the lateral fold to the center of the venter. There are consequently rows one to five on each side of the venter in all *Ophisaurus*.

The following characters were recorded for both sides of the head; scales around parietals, upper labials, lower labials, preoculars, lorilabials, loreals, postnasals, labials entering orbit, contact of the uppermost postnasal. The data for each side were analyzed separately. No significant bilateral differences were observed for any of the above characters in any of the *Ophisaurus* studied.

DISCUSSION OF THE GENUS *OPHISAURUS**OPHISAURUS* Daudin

Anguis Linnaeus, 1766, Syst. Nat., 12th ed., II, p. 391. *Lacerta* Pallas, 1775, Nov. Comment. Acad. Petrop., XIX, p. 435, pls. IX, X. *Chalcida* Meyer, 1795, Synops. Rept., p. 31. *Seps* Daudin, 1803, Hist. Nat. Rept., IV, p. 351. *Ophisaurus* Daudin, 1803, Hist. Nat. Rept., VII, p. 346 (type species *ventralis*). *Chamaesaura* Schneider, 1804, Hist. Amph., II, p. 215. *Bipes* Oppel, 1811, Ordn. Rept., p. 43 (type species *pallasii*). *Proctopus* Fischer de Waldheim, 1813, Mem. Soc. Imp. Sci. Mosc., IV, p. 241 (type species *pallasii*). *Pseudopus* Merrem, 1820, Tent. Syst. Amphib., pp. 13 and 78 (type species *apus*). *Hyalinus* Merrem, 1820, Tent. Syst. Amphib., pp. 14 and 79 (type species *ventralis*). *Dopasia* Gray, 1853, Ann. Mag. Nat. Hist., (2), XII, p. 389 (type species *gracilis*). *Ophiseps* Blyth, 1853, Jour. Asiatic Soc. Bengal., XXII, p. 655 (type species *tessellatus*). *Hyalosaurus* Günther, 1873, Ann. Mag. Nat. Hist., (4), XI, p. 351 (type species *koellikeri*).

The genus *Ophisaurus* was proposed by Daudin (1803) to contain *Anguis ventralis* Linnaeus. Boulenger (1885) discussed five species which he referred to *Ophisaurus*. Cope (1900) considered the genus monotypic, containing only the single North American species, *ventralis*. However, subsequent writers have apparently preferred Boulenger's arrangement, and have included both old and new world forms under this generic heading. As defined at present, the genus *Ophisaurus* contains eight species and a total of nine races. They are as follows:

- Ophisaurus apus* Pallas—southeastern Europe to Turkestan and Afghanistan.
- Ophisaurus attenuatus attenuatus* Baird—middle western United States.
- Ophisaurus attenuatus longicaudus* McConkey—southeastern United States.
- Ophisaurus buttkoferi* van Lidth de Jeude—Borneo.
- Ophisaurus compressus* Cope—southeastern United States.
- Ophisaurus gracilis* Gray—south-central Asia.
- Ophisaurus harti* Boulenger—southeastern Asia.
- Ophisaurus koellikeri* Günther—north Africa.
- Ophisaurus ventralis* Linnaeus—southeastern United States.

DESCRIPTION OF THE GENUS

A lateral fold present; limbs absent externally or reduced to vestiges of the hind pair; scales squarish-rhomboidal, forming straight longitudinal and transverse series; tail much longer than body, with at least the four mid-dorsal rows of scales keeled; ten longitudinal series of ventral scales; teeth with conical or sub-spherical crowns; pterygoid teeth present; palatine and vomerine teeth present or absent.

The first two characters given in the paragraph above serve, when taken in combination, to distinguish *Ophisaurus* from all other Anguidae.

KEY TO THE NORTH AMERICAN *OPHISAURUS*

- 1 One or two upper labials of each side in contact with the orbit; frontonasal usually double; scales along lateral fold numbering 97 or less (coastal South Carolina through peninsular Florida) *O. compressus*
- 1' Upper labials separated from orbit by lorilabials; frontonasal single; scales along lateral fold numbering 98 or more 2
- 2 White markings (absent only in the very young) occurring on posterior corners of scales, never primarily in middle of scales; no distinct mid-dorsal stripe present; no dark stripes present on venter (southeastern United States, from North Carolina to Florida, westward to Louisiana and southeastern Oklahoma, and northward to east-central Missouri) *O. ventralis*
- 2' White markings occurring in middle of scales, often forming smooth stripes; a distinct mid-dorsal stripe generally present in adults, always in young; dark stripes usually present on scale rows one and two of venter 3
- 3 Length of complete and unregenerated tail of adult less than 2.4 times snout-vent

- length (northwestern Indiana to southern Wisconsin, southwestward to Louisiana and Texas) *O. attenuatus attenuatus*
 3' Length of complete and unregenerated tail of adult 2.4 or more times snout-vent length (southeastern United States, from Virginia and Kentucky southward to central Florida and Mississippi) *O. attenuatus longicaudus*

OPHISAURUS VENTRALIS Linnaeus

Anguis ventralis Linnaeus, 1766, Syst. Nat., 12th ed., II, p. 391. *Ophisaurus ventralis*, Daudin, 1803, Hist. Nat. Rept., VII, p. 352, pl. 88. *Chamaesaura ventralis*, Schneider, 1804, Hist. Amph., II, p. 215. *Hyalinus ventralis*, Merrem, 1820, Tent. Syst. Amph., p. 79. *Ophisaurus punctatus* Cuvier, 1829, Regne Animal, 2nd. ed., II, p. 70. *Ophisaurus striatulus* Cuvier 1829, Regne Animal, 2nd. ed., II, p. 70. *Ophisaurus lineatus* Gray, 1838, Ann. Mag., I, p. 391.

Diagnosis: An *Ophisaurus* differing from other North American members of the genus by the following characters taken in combination: the white spots of the dorsum occur on the posterior edges of the scales, never primarily in the middle of the scales; and the scales along the lateral fold number 98 or more.

Geographic Range: The Atlantic and Gulf Coastal Plains of southeastern United States from North Carolina through eastern Louisiana; with extensions along river valleys as far as southeastern Oklahoma, east-central Missouri, and the Piedmont of Georgia.

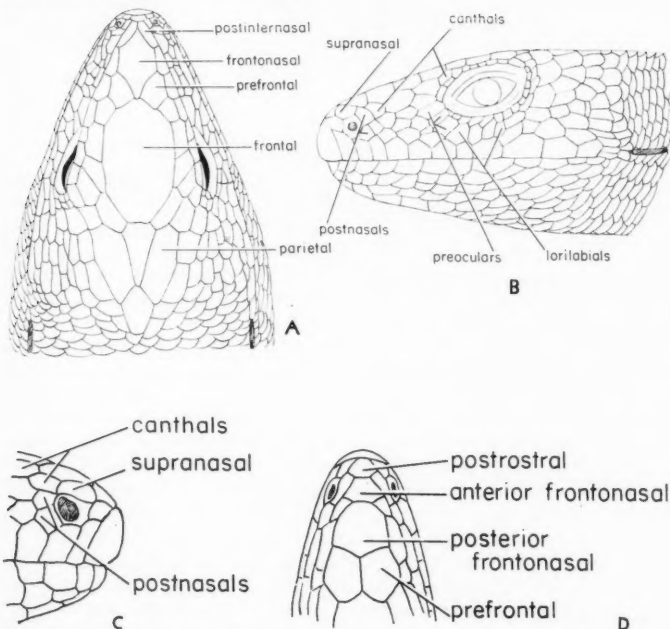


Fig. 1.—Scale characters of American *Ophisaurus*—A. *O. ventralis*, head from above; B. *O. ventralis*, head from side; C. nasal region of *O. a. longicaudus*; D. snout, from above, of *O. compressus*.

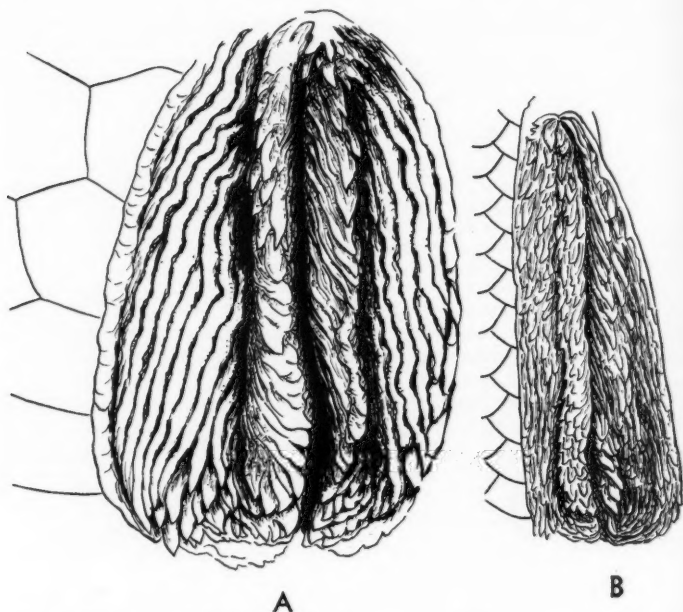


Fig. 2.—Hemipenes of *Ophisaurus*—A. *O. compressus*; B. *O. attenuatus longicaudus*.

Type: The present status of the type is unknown. Lönnberg (1896) lists a "discoloured, but otherwise good specimen of *Ophisaurus* [sic] *ventralis* Linnaeus" from the collection of the Zoological Museum of the Royal University in Upsala, Sweden. However, he does not list this specimen with the known Linnaean types. Klauber (1948) considered the Upsala specimen to be the type, but now agrees with me that he was not justified in doing so (personal communication).

Since more than one form of glass lizard is known to occur in the region of the type locality, the question arises whether Linnaeus had at hand a specimen of *Ophisaurus ventralis* when he described *Anguis ventralis* in the twelfth edition of *Systema Naturae*. It is important to note that he bases the description on a plate in Catesby (1731), and that this plate shows a green lizard. Furthermore, the description contained in the thirteenth edition of *Systema Naturae* refers to the green color of the type specimen. Since no other North American *Ophisaurus* is noticeably green, I believe it is correct to conclude that Linnaeus had a specimen of *Ophisaurus ventralis*.

The description in the thirteenth edition of *Systema Naturae* also contains a statement to the effect that the tail is three times as long as the body. The unregenerated tail in adult *Ophisaurus ventralis* is generally not over 2.25 times the body length, but approaches three times the body length in both *attenuatus longicaudus* and *compressus*. Nevertheless, I believe that the color description outweighs tail length as evidence, and prefer to conclude that

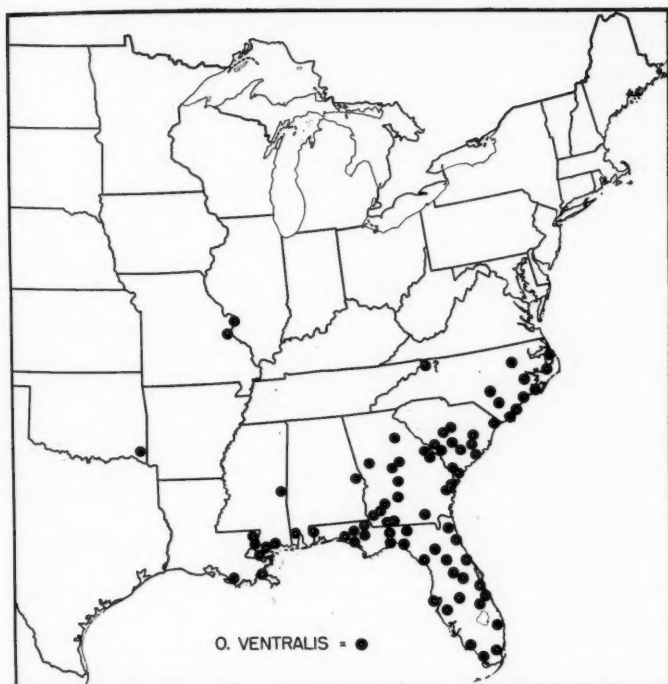


Fig. 3.—Distribution of *Ophisaurus ventralis*.

Linnaeus simply made a casual estimate of the length of the tail of the specimen he was describing.

Neill (1949) has restricted the type locality to the vicinity of Charleston, to which I agree. Since the type of *Ophisaurus ventralis* has not been available to me, I will describe below a topotype that I consider to be representative of the species.

Description of Topotype: AMNH 50843; a female from Charleston, South Carolina; collected in August, 1933. Snout-vent length 221, tail length (original) 98, regeneration 36, head length 22.9, head width 8.7, eye diameter 4.7, dorsal scales in 14 longitudinal series, scales around parietal 8-7, upper labials 11-11, lower labials 7-7, preoculars 3-3, lorilabials 4-5, loreals 10-8, postnasals 1-1, scales around tail 22.

Frontonasal single; labials separated from orbit by lorilabials and suboculars; prefrontals separated by a posterior extension of the frontonasal; the single postnasal on each side is not in contact with the supercanthal row, but the anteriormost canthal is almost in contact with the postnasal; postinternasals in contact medially; five supraoculars; canthals extending to above the middle of the eye; frontal broad and rectangular posteriorly, pointed ante-

rior end meeting the posterior extension of the frontonasal; interparietal broad anteriorly, tapering to a point posteriorly; occipital as broad as the interparietal at its greatest width; frontoparietal in contact with the fourth supraocular; first and second upper labials in contact with the nasal.

Body broader than high; dorsal scales slightly convex, but not keeled; ventrals smooth and flat. Ear opening oval, larger than nostril.

The dorsal pattern of AMNH 50843 presents an overall checkered appearance. This is produced by a dark brown (0-1-8°) spot occupying roughly the center of most of the scales in the first three rows on each side. All the scales of row one are so occupied, nearly all the scales of row two, and about half of the scales of row three. In general, these spots have an oblong shape, just reach the anterior edge of the scales they are in, do not quite extend to the posterior edge, and are about half a scale wide at their widest extent. The ground color of the scales in rows one to three is tan (0-12-3°).

Rows four and five have the dark brown (0-1-8°) color filling all of the scale with the exception of the upper and lower posterior corners, which are white. Row six is similar, but the white occupies the entire upper and lower edges of each scale. Row seven is entirely white with scattered dark brown (0-1-8°) flecks. Thus the lateral pattern of this specimen consists of three dark brown (0-1-8°) stripes running through the middle of the scales, and separated by two rows of narrow white spots. Since each brown spot is wider anteriorly, the stripes produced are irregular in appearance.

On the head the brownish ground color (0-6-5°) is spotted with dark brown (0-1-8°) marks of varying size. These markings are few on the snout and become more numerous from front to rear. The markings tend to be in the middle of the plates and do not cross sutures.

Between the angle of the mouth and the anterior end of the lateral fold are several vertical bars. In many specimens these bars may extend from the level of the lateral fold, or just below that level, to scale row four. They consist of a white center covering the posterior half of one transverse scale row and the anterior half of the succeeding row, and a black edge half a scale row wide on either side of the white. This specimen has six bars on each side. Most of them are only two or three longitudinal scale rows long; one bar on the left side and two on the right reach the limits described above. In the region of the vertical bars there is no additional pattern. The ground color is the same as that of the dorsum (0-12-3°).

Scale row one of the venter bordering the anteriormost inch of the lateral fold has a few dark brown (0-1-8°) spots on it about half a scale in size. Scale rows one and two have a number of minute brown flecks scattered throughout their length. Otherwise, the pattern of the venter is immaculate yellowish-white (Y-19-3°).

The pattern on the tail is the same as that on the body, modified only by the reduced number of scales around the tail. Shortly behind the anus the dorsal area of light brown ground color with dark brown spots involves only rows one, two, and half of row three; the lateral area of dark brown stripes covers the lower half of row three and all of rows four through six; and, except for minute brown flecks, the remaining ten longitudinal rows are the same pure light yellow as the belly.

Variation in coloration: At hatching *Ophisaurus ventralis* is not at all similar to the topotype described above. The ground color of the dorsum

is khaki. On rows five, six, seven, and the lower half of row four the anterior portion of each scale is nearly black and the posterior portion is dark brown. The effect produced is that of a single, broad, dark lateral stripe. In some specimens there is a small brown mark at the upper edge of each scale in the mid-dorsal scale rows, which produces a suggestion of a vertebral stripe. Generally, however, a plain dorsum is the case.

Anteriorly, at and just behind the level of the ear opening, there are usually several white vertical bars like those described on the topotype. In very old adults, these vertical bars may become obliterated by the profusion of white markings that develop in that region.

The venter of young *Ophisaurus ventralis* is white. As the animal matures this changes gradually to yellow. Large specimens are often a rich canary yellow in that region.

As an *Ophisaurus ventralis* matures, the black spots of the lateral stripe becomes more discrete, the color in between the spots lightens, and each spot develops a posterior projection that touches the mark in the adjacent scale. Thus the lizard comes to have three narrowly separated black lateral stripes. At this stage the dorsum is still uniformly light brown or khaki-colored, the venter is light yellow, the anterior bars are still distinct, and the animal is anywhere between young adulthood and full maturity. The predominant impression one receives is that of a brown lizard.

In some adult *Ophisaurus ventralis* the black begins to spread onto the scales of the dorsum. Gradually the centers and anterior portions of all the dorsal scales darken, and at the same time the posterior corners lighten. Eventually a speckled pattern is produced. Generally, when this stage is reached the posterior corners of the scales of the middle six rows are brownish yellow, and those of the lateral rows are white. The remainder of each scale is almost black. At this stage the increased pigmentation has frequently obliterated the anterior vertical bars. The venter becomes bright yellow.

Old *Ophisaurus ventralis* with pattern as described above appear green when living. Actually there is very little green present. Only spots in the posterior corners of the scales become a light green. There is no other green color on the animal recognizable as such. The contrast of the yellow venter and blackish dorsum probably is partly responsible for the illusion of a greenish cast over the entire dorsal part of the lizard. Sometimes the green spots are so light as to be scarcely noticeable; at other times the green is quite bright and distinct, being present on both dorsal and lateral scales. A living specimen from Millers Ferry, Washington County, Florida, has bright green coloration and is described herewith: Pattern of stripes and spots as in the topotype; vertical bars still discernible; ground color of back brown (0-5-5°); top of head somewhat darker (00S-4-7°); venter (YYO-16-11°) varying through (YYO-15-6°) near the end of the tail; lateral dark stripes and dorsal dark spots not discernibly different from black; green spots very bright, although light (E-15-10°).

Frequently in *Ophisaurus ventralis* one or at most two scale rows of the venter at the anterior end of the lateral fold show touches of the dorsal dark pigmentation. In young and young-adult specimens this is the only dark pigmentation below the lateral fold. In old specimens there may be a little dark color just below the edge of the lateral fold all along the body, but in no specimens of *Ophisaurus ventralis* does the venter as far back as the anus have more

than scattered dark flecks on it, and these dark markings are never on any but the two rows of ventral scales adjacent to the lateral fold. There are never distinct stripes below the lateral fold in *Ophisaurus ventralis*.

TABLE 1.—Variation in scutellation of *Ophisaurus ventralis*

| Character | M | O.R. | σ | V | N |
|---------------------------|-------------------|--------|------------------|------------------|-----|
| scales around parietal | 7.15 \pm .042 | 6-10 | .586 \pm .030 | 8.2 \pm .418 | 192 |
| upper labials | 10.72 \pm .046 | 9-12 | .654 \pm .033 | 6.1 \pm .303 | 202 |
| lower labials | 7.07 \pm .047 | 5-9 | .669 \pm .034 | 9.5 \pm .476 | 199 |
| preoculars | 3.35 \pm .047 | 2-5 | .657 \pm .033 | 19.6 \pm .993 | 195 |
| lorilabials | 3.80 \pm .067 | 1-6 | .912 \pm .047 | 24.0 \pm 1.238 | 188 |
| lorealis | 9.17 \pm .130 | 5-15 | 1.822 \pm .092 | 19.9 \pm 1.003 | 197 |
| postnasals | 1.96 \pm .025 | 1-3 | .361 \pm .018 | 18.4 \pm .911 | 204 |
| scales around tail | 20.89 \pm .103 | 20-24 | 1.038 \pm .073 | 5.0 \pm .350 | 102 |
| scales along lateral fold | 103.68 \pm .375 | 98-109 | 2.649 \pm .265 | 2.6 \pm .255 | 50 |

TABLE 1a.—Variation in scutellation of *Ophisaurus ventralis*

With the exception of N, which refers to the number of specimens in the sample under consideration, the figures given below are percent.

| Separation of Prefrontals in Midline | | | |
|--|----------------|----------------------|-----|
| in contact | not in contact | contact questionable | N |
| 18 | 61 | 21 | 97 |
| Contact of Uppermost Postnasal with Supercanthal Row | | | |
| in contact | not in contact | contact questionable | N |
| 78 | 9 | 13 | 101 |
| Dorsal Scale Rows | | | |
| 14 or less | more than 14 | | N |
| 28 | 72 | | 101 |

Hemipenis: The hemipenis of *O. ventralis* is about six subcaudals long, and is essentially similar to that of *O. a. longicaudus*.

SPECIMENS EXAMINED

Alabama: Lee County: UMMZ 89903. Mobile County: MCZ 608(2), 991; TU 2367; UMMZ 97424-5; USNM 42556, 58190-5.

Arkansas: USNM 4985.

Florida: AMNH 1921-2, 22711; ERA-WTN unnumbered; USNM 78471. Alachua County: AMNH 597, 63779, 63938; CM 18817; DBUF 61, 393, 2032, 2052, 2394(4), 2549, 2712(2), 2870; JWC FC626; UMMZ 56550-2, 56603, 57038, 57353, 57750-1, 57760, 77207-8, 85559; USNM 5135, 12783, 20811, 75128, 89451. Bay County: AMNH 58911; ERA-WTN 15002. Brevard County: AMNH 7577; MCZ 6803, 12515; USNM 12004, 13645, 13660. Calhoun County: ERA-WTN 15006-8, unnumbered (2). Collier County: ERA-WTN 15012; UMMZ 97440. Dade County: USNM 38154-6. Duval County: AMNH 22400, 22422, 22432; CNHM 2995-6; ERA-WTN unnumbered; USNM 9687(2). Escambia County: CNHM 53675; MCZ

611; UMMZ 97439; USNM 9358 (4). Indian River County: MCZ 12516, 20179-80. Jackson County: DBUF 2651 (3). Lake County: ERA-WTN 15000, 15005, 15016, 15018; UMMZ 77486-7, 97438; USNM 16949, 24345, 81098. Leon County: UMMZ 81156. Levy County: ERA-WTN 15004, 15011, 15015. Madison County: UMMZ 72804. Manatee County: CM 24917; UMMZ 75671; USNM 72560. Marion County: BCB 5283-6; CNHM 7472-3; UIMNH 17059; UMMZ 46923, 95571-2. Monroe County: USNM 4168(2). Okeechobee County: AMNH 63354-5, 63927. Orange County: ERA-WTN unnumbered; MPM 688-92, 9449, 9461; USNM 81986. Palm Beach County: CM 20174. Pinellas County: UMMZ 61643. Polk County: CM 6983, 16498. St. Johns County: AMNH 60036, 63431, 63925; DBUF 1085. Taylor County: UMMZ 98717-8. Volusia County: UMMZ 56158; USNM 31049. Wakulla County: DBUF 2042. Walton County: ERA-WTN 15013-4. Washington County: AMNH 7428.

Georgia: MCZ 602; UMMZ 3829; USNM 5038(2), 5138, 13476, 27326. Baker County: JWC L7. Baldwin County: MCZ 623. Bibb County: UMMZ 97437. Burke County: ERA-WTN unnumbered. Chatham County: CM 28844. Clarke County: MCZ 605. Clinch County: AMNH 63926. Dougherty County: JWC L10, L11. Grady County: CNHM 8115-6. Liberty County: CM 18792; USNM 5137(2), 45112-3. Meriwether County: UMMZ 98049. Miller County: JWC L52. Pulaski County: USNM 12754. Richmond County: ChM 36206; ERA-WTN unnumbered (2). Thomas County: CNHM 28448, 34744, 35882. Turner County: AMNH 43140, 43154-5.

Louisiana: BUM 1187. Orleans Parish: TU 5269, 11236(2). Plaquemines Parish: USNM 14142(2). St. Tammany Parish: TU 2361(9), 2383; UMMZ 97436. Terrebonne Parish: USNM 52217. Washington Parish: TU 12215, 12444.

Mississippi: Hancock County: CM 4308; USNM 44764-6. Harrison County: AMNH 46732, 46860-1, 57753-5, 57757, 57840-4; CNHM 21524; UMMZ 71774, 76836-7, 76839, 78524, 94019, 95002, 95004; USNM 6241(5), 48192, 51091-4. Lauderdale County: UMMZ 90142A.

Missouri: USNM 48368. Jefferson County: USNM 58197. St. Louis: MCZ 6380.

North Carolina: MCZ 4830; USNM 11400(4). Ashe County: NCSM unnumbered. Bladen County: NCSM unnumbered. Brunswick County: AMNH 22802-5; USNM 107761. Carteret County: MCZ 3399, 3402(2). Craven County: USNM 6419. Cumberland County: NCSM unnumbered (3). Dare County: CM 22935-6, 23182, 23204; USNM 72580. Edgecombe County: NCSM unnumbered. Hyde County: CM 15098; USNM 108688. New Hanover County: UMMZ 88878; USNM 9260, 90898. Onslow County: UMMZ 91442(2).

Oklahoma: McCurtain County: UMMZ 86538.

South Carolina: USNM 33883. Aiken County: ChM 33.229.16. Barnwell County: USNM 13809. Beaufort County: CM 24958; MCZ 3410. Berkeley County: ChM 29.71.3; USNM 10376. Charleston County: AMNH 50843, 60264; ChM 5153, 30.132.2, 31.84, 33.207.10, 33.218.7, 34.98, 40.153.2, 49.70.3, 50.155.1-6; CNHM 4733; ERA-WTN unnumbered (2); MCZ 613, 617(2), 624; UMMZ 97195(2); USNM 5130(2), 48358-9. Dorchester County: UMMZ 94944; USNM 110488. Horry County: ChM 33.327.15; USNM 110473-4. Jasper County: CM 27796, 27812. Lexington County: CM 8381; CNHM 52949. Orangeburg County: USNM 14584. Richland County: ChM 31.219.12. Williamsburg County: ChM 5108.

OPHISAURUS COMPRESSUS Cope

Ophisaurus ventralis compressus Cope, 1900, Ann. Report U. S. Nat. Mus. for 1898, p. 501, fig. 90.

Diagnosis: An *Ophisaurus* differing from other North American members of the genus in that one or more upper labials of each side are not separated from the orbit by lorilabials, and in that the scales along the lateral fold number 97 or less.

Geographic Range: Coastal areas and offshore islands of South Carolina, Georgia, and Florida; sand pine scrub and adjacent flatwoods areas of peninsular Florida. I have not yet seen any specimens of *O. compressus* from North Carolina, but since the coast of that state is essentially similar to the



Fig. 4.—Distribution of *Ophisaurus compressus*.

coast of South Carolina, it seems likely that *O. compressus* will eventually be found there.

Type: USNM 21359, a male from South Island, Georgetown County, South Carolina; collected by E. P. Alexander.

Description of Type: Snout-vent length 189; tail length 495 (the tail is complete except for the terminal scale); head length 21.6; head width 7.4; eye diameter 3.8 (approximate, eye is sunken into head); dorsal scales in 14 longitudinal series; scales around parietal 9-6; upper labials 10-10; lower labials 8-7; preoculars 3-2? (specimen scarred on right side just at anterior corner of eye); lorilabials 1-1, 1-1 (anterior lorilabial of each side separated from the posterior one by two upper labials); loreals 10-9; postnasals 2-2; scales around tail 20.

Two frontonasals; two upper labials of each side separated from the orbit only by a row of very small suboculars; prefrontals in contact in the midline; uppermost postnasal of each side in contact with the supercanthal row; post-internasals separated by the frontonasals; supraoculars five; canthal row extending to above middle of eye; occipital not clearly defined; frontoparietal in contact with the fourth supraocular; first and second upper labials of left side in

contact with the nasal, only the first upper labial of the right side in contact with the nasal.

The body is noticeably compressed vertically, but other *O. compressus* that I have seen do not show this flattening. It is probable that the type was subjected to desiccation before being preserved. Cope mentions in the original description that the subcaudal scales are longer than wide. I do not find this character to be true for the type, or for any other specimen of *Ophisaurus compressus*.

The anterior part of the body is heavily marked with irregular white spots. These white markings are generally only one to a scale, and are always associated with the edges of the scale, rather than the middle. The mid-dorsal rows have white on the ventral half of the scales, but almost none on the upper half. Laterally, a dark brown stripe becomes apparent about halfway back on the body, and continues two-thirds of the way out onto the tail. This stripe occupies the lower half of row four and the upper one-third of row five. Thus on the body there are three and one-half scale rows on each side, or a total of seven, between the lateral stripes. This dorsal area is for the most part unpatterned, and is of a yellowish tan color. There is a suggestion of a mid-dorsal stripe, caused by dark pigment in the scale centers of row one on each side. At the level of the anus two dorsal scale rows drop out, leaving only four rows between the lateral stripes of the tail. This separation prevails as far out as the stripes are evident.

The coloration below the lateral stripes is yellowish-white and is similar to the color of the venter. No markings are present below the lateral stripes on the posterior part of the body, although scattered flecks overlap onto the venter in the anterior portion. The head has the ground color similar to the dorsal color, with white markings which are concentrated along the sutures.

Variation in coloration: Unfortunately I did not compare the pattern of the type with the color atlas of Villalobos and Villalobos, but I have had the opportunity of using that standard to describe the color of the only living specimen of *Ophisaurus compressus* that has been available to me. This description is given below.

The specimen referred to was collected by Mr. W. T. Neill, April 20, 1951, at Burbank, Florida. It is about 155 mm. in snout vent length, with 205 mm. of original tail remaining and about 23 mm. of regeneration. The pattern is essentially similar to that of the type. Two very dark brown (SO-1.4°) lateral stripes extend from behind the eye to the end of the remaining original tail. Spots of this same color in the dorsal half of each scale of row one produce an indefinite mid-dorsal stripe. The ground color between the lateral stripes is light brown (O-8-3°). For three to four rows on each side of the tail below the lateral stripe there is a delicate peach color (OOS-17-8°). This color is not apparent on the body, where the ground color of the dorsum fades gradually into the clear yellowish white of the venter (OY-19-3°). The color of the mid-subcaudal region is the same as that of the belly. The top of the head is unmarked, being of a uniform light brown (O-6-3°). The sides of the head are heavily marked with brown, yellow and white. This mottled effect extends along the lateral area for about an inch and a half before fading out. It resembles here the dominant pattern on the entire anterior half of the type. It is my opinion that the type is unusual in this respect, for most *compressus* do not have a great deal of white

markings on the body anywhere, being more like the above specimen. Mr. Neill tells me that the peach color mentioned above is usually much more evident on specimens of *compressus* from the Marion County scrub and adjacent regions, generally occupying the entire subcaudal region and most of the venter. He says also that the coastal specimens of *compressus* do not have any peach color on their bodies or tail. Whether or not this difference is constant, and whether it is of taxonomic import if constant will require additional information that I do not at present possess.

Two specimens of *Ophisaurus compressus* collected by Mr. Neill on Wolf Island, McIntosh County, Georgia, are unusual in that the lateral stripe occupies the lower half of scale row four and only the upper edge of row five. These specimens are small (120 and 130 mm. snout-vent length) and it may be that they would develop broader stripes as they grew older. However, their gonads indicate maturity, and specimens of a similar size from elsewhere do not have lateral stripes as narrow as do these specimens. It is possible that the glass snakes on Wolf Island and other outlying islands of the Georgia and South Carolina coast may be taxonomically recognizable. Of course, it will be necessary to acquire many more specimens before any definite conclusions may be drawn.

TABLE 2.—Variation in scutellation of *Ophisaurus compressus*

| Character | M | O.R. | σ | V | N |
|---------------------------|------------------|-------|------------------|------------------|----|
| scales around parietal | 7.76 \pm .151 | 6-10 | 1.060 \pm .107 | 13.7 \pm 1.384 | 49 |
| upper labials — males | 11.24 \pm .102 | 10-12 | .512 \pm .072 | 4.5 \pm .636 | 25 |
| females | 10.54 \pm .166 | 9-12 | .815 \pm .118 | 7.7 \pm 1.111 | 24 |
| lower labials | 7.31 \pm .130 | 6-9 | .908 \pm .092 | 12.4 \pm 1.253 | 49 |
| preoculars | 3.31 \pm .103 | 1-4 | .694 \pm .073 | 21.0 \pm 2.214 | 45 |
| lorilabials | 2.37 \pm .128 | 1-5 | .869 \pm .091 | 36.7 \pm 3.826 | 46 |
| loreals | 9.57 \pm .332 | 5-14 | 2.252 \pm .235 | 23.5 \pm 2.450 | 46 |
| postnasals — males | 2.38 \pm .142 | 1-3 | .696 \pm .100 | 29.2 \pm 4.215 | 24 |
| females | 1.92 \pm .056 | 1-2 | .276 \pm .040 | 14.4 \pm 2.078 | 24 |
| scales around tail | 19.73 \pm .200 | 18-22 | 1.021 \pm .142 | 5.2 \pm .721 | 26 |
| scales along lateral fold | 88.89 \pm .570 | 83-97 | 2.961 \pm .403 | 3.3 \pm .453 | 27 |

A young specimen of *O. compressus* from Cedar Keys, Levy County, Florida, has no color anterior to the anterior end of the lateral fold. This lizard is 80 mm. in snout-vent length and is ERA-WTN 15021. An even smaller specimen (UMMZ 97441, snout-vent length 72 mm.) is likewise lacking in dark pigmentation on the head and neck, although it is not as purely white as the Cedar Keys specimen. This lizard is from Sarasota County, Florida.

One outstanding difference between *O. compressus* and the other North American glass lizards is the presence of two frontonasals, rather than one. This character, however, is not invariable. Of the *compressus* that I have examined, twenty percent had only one frontonasal.

Hemipenis: *O. compressus* differs from the other North American *Ophisaurus* in that the hemipenis has two ridges, one on either side of the sulcus, that run the entire length of the organ. These ridges are spinose on top and rugose laterally. The remainder of the hemipenis is plicate and fleshy, except for a few small spines at the base of the ridges. The hemipenis of a speci-

TABLE 2a.—Variation in scutellation of *Ophisaurus compressus*

With the exception of N, which refers to the number of specimens in the sample under consideration, the figures given below are percent.

| Separation of Prefrontals in Midline | | | |
|--|----------------|----------------------|----|
| in contact | not in contact | contact questionable | N |
| 78 | 11 | 11 | 26 |
| Contact of Uppermost Postnasal with Supercanthal Row | | | |
| in contact | not in contact | contact questionable | N |
| 60 | 20 | 20 | 25 |
| Dorsal Scale Rows | | | |
| 14 or less | more than 14 | | N |
| 92 | 8 | | 26 |

men from Manatee County, Florida, is shown in Figure 2. It is approximately five subcaudals long.

SPECIMENS EXAMINED

Florida: Brevard County: MCZ 13647-9; USNM 12004. Collier County: ERA-WTN 13013; UMMZ 97442. Dade County: BCB 4462; USNM 27737, 32085, 83301, 85262, 95798. Highlands County: AMNH 65682. Lee County: UIMNH 21256. Levy County: CM 27136; ERA-WTN 15021. Manatee County: UMMZ 96635. Marion County: ERA-WTN 15003, 15009, unnumbered. Palm Beach County: MCZ 12825; UMMZ 54090(2). Pinellas County: UMMZ 61642; USNM 10584. Polk County: CM 16514. Sarasota County: UMMZ 97441.

Georgia: McIntosh County: ERA-WTN unnumbered (2).

South Carolina: Charleston County: ChM 33.273, 34.125; MCZ 615. Georgetown County: USNM 21359.

OPHISAURUS ATTENUATUS ATTENUATUS Baird

Ophisaurus ventralis attenuatus Baird, 1880, in Cope, Bull. U. S. Nat. Mus. 17, p. 18. *Ophisaurus ventralis sulcatus* Cope, 1880, Bull. U. S. Nat. Mus. 17, p. 18. *Ophisaurus attenuatus*, Boulenger, 1885, Cat. Liz. Brit. Mus., 2nd ed., II, p. 282.

Diagnosis: An *Ophisaurus* differing from other North American members of the genus by the following characters taken in combination: the white marks on the scales occupy the middle of the scales, and the unregenerated tail of the adult is less than 2.4 times the body length.

Geographic Range: The races of *Ophisaurus attenuatus* appear to be separated by the Mississippi and Ohio Rivers, but the extent of the area of intergradation cannot as yet be defined. For purposes of convenience, each state will be considered to be inhabited by only one race. *Ophisaurus attenuatus* is recorded from the following states: Louisiana, Arkansas, Missouri, Illinois, Indiana, Wisconsin, Iowa, Nebraska, Kansas, Oklahoma, and Texas.

Yarrow (1884) records a glass lizard from Jalapa, Mexico. Cope (1900) lists what is presumably the same specimen as USNM 6078. I have examined the specimen and find it to be typical *attenuatus attenuatus*. However, there is some doubt that it actually came from Mexico. Jalapa is located in the state of Veracruz, five hundred miles from the nearest record for *Ophi-*

saurus a. attenuatus in southern Texas. Smith and Taylor (1950) do not accept the Mexican record. The matter is complicated by the existence of AMNH 15473, which has the following data: Sand dunes west of Laguna de los Cocos, Veracruz; "greyish, in grass, collected by a caretaker with machete who ruined the specimen for scientific purposes," (field notes of collector). It was collected June 8, 1919, by Paul Ruthling. It resembles *attenuatus* in that a mid-dorsal stripe is present, but it is like *ventralis* in that the white markings form stripes running along the edges of the scales, and in that there is no dark pigmentation below the lateral fold.

It is probably true that USNM 6078 has incorrect data, and it may be true that AMNH 15473 is a misplaced *ventralis*, but the peculiar appearance of the latter specimen and the exact nature of the data that accompany it require that further consideration be given the possibility of a distinct kind of *Ophisaurus* occurring along the east coast of Mexico.

Type: The name *attenuatus* was first published by Cope (1880), but he clearly stated that it was a manuscript name of Baird's. It was also brought out that Baird distinguished *attenuatus* from *ventralis* by the number of longitudinal series of dorsal scales; the former having 14, and the latter 16. *O. attenuatus* was further defined as being a western race. Thus it seems clear

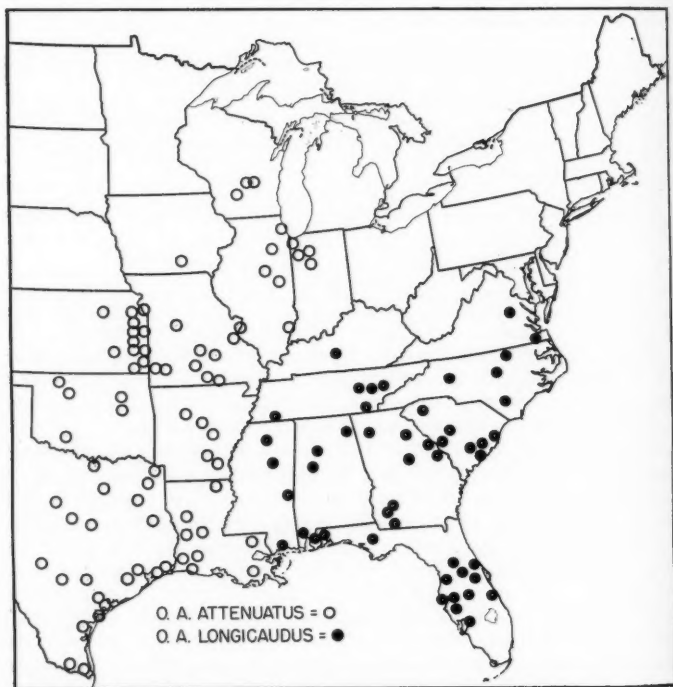


Fig. 5.—Distribution of *Ophisaurus attenuatus*.

that Baird's name is applicable to the glass lizards of western United States. However, no type specimen of *attenuatus* has as yet been named. Therefore, I designate USNM 15537 as the neotype of *Ophisaurus attenuatus attenuatus* Baird; this specimen is a male from Cook County, Texas, collected by G. H. Ragsdale.

Description of Type: Snout-vent length 162; tail length 351 (tail complete); head length 19.0; head width 6.6; eye diameter 3.8; dorsal scales in 14 longitudinal series; scales around parietal 7-7; upper labials 11-11; lower labials 6-6; preoculars 3-3; lorilabials 6-5; loreals 8-9; postnasals 1-2; scales around tail 18.

Frontonasal single; labials separated from orbit by lorilabials and suboculars; prefrontals separated by frontonasal, frontonasal fused with right prefrontal; uppermost postnasals not in contact with supercanthal row; postinternasals in contact medially; five supraoculars; canthals extending to above middle of eye; frontal in contact with frontonasal anteriorly; occipital half as wide as interparietal; frontoparietal in contact with the third and fourth supraoculars; first and second upper labials in contact with the nasal.

Scale rows one to three of dorsum and tail convex, but not keeled. Ear opening elongate-oval, larger than nostril. Tail 2.17 times snout-vent length.

The ground color of the dorsum is buff (OOY-13.4°), and occupies rows one through three and the upper third of row four. The upper one-half of the two mid-dorsal rows is light brown (SO-8.5°). This forms a light mid-dorsal stripe the length of the body, which is visible nearly three-fourths of the distance to the tip of the tail. The lateral pattern is of three dark brown stripes (OOS-3.4°) separated by two yellowish-white stripes (YYO-17.4°) as follows: dark brown stripes on lower two-thirds row four and upper one-fourth row five; lower one-fourth row five and upper one-fourth row six; lower one-fourth row six and upper edge row seven; yellowish-white stripes on middle of rows five and six; all but upper edge of row seven yellowish-white.

These stripes are broken up at about the level of the anterior end of the lateral fold. Anteriorly from there to the eye the pattern is mottled brown and yellowish-white in the lateral area. This mottled pattern extends to the level of the anterior edge of the eye on both upper and lower labials. The ground color of the top of the head is close to that of the dorsum (O-9.3°).

The venter is yellowish (YYO-17.4°). Two light brown stripes (O-8.11°) run along the junction of ventral rows one and two, and two and three of each side.

On the tail just posterior to the anus, there are five lateral brown stripes. The darkest (OOS-3.4°) of these is at the top, and the lightest (SO-8.5°) at the bottom. Between the brown stripes of the tail are yellowish-white stripes similar to those of the body, but varying from yellowish-white (YYO-17.2°) to yellow (OOY-17.5°). The latter color occupies the ventral region of the tail.

Variation in coloration: In large adult specimens the lateral whitish stripes on rows five and six lose their smoothness and become broken or contorted at the scale margins. Frequently a white mark is developed in the posterior part of each scale at right angles to the stripe. The effect produced is that of a row of "plus marks."

Also in older specimens, white markings invade the dorsum. These white

spots occur mostly at the junction of rows one and two, and two and three. They are spaced at longitudinal intervals of about five scales. Dark brown pigment generally surrounds these white spots. The effect produced is that of short, irregular cross-bars all along the back, each extending from the lower half of row one to the upper half of row three. The remainder of row three becomes primarily dark brown, as does all of row four, except that the upper edge of row four is variously marked with white. Correlative with these changes is an increase in ventral color. Also at this age the head becomes nearly all dark brown, with white along the sutures, and the old ground color only on the snout. The cross-bars mentioned above become gradually less evident on the tail. The pattern on the tail between the vertebral stripe and the lateral stripe becomes "scribbled" in appearance.

TABLE 3.—Variation in scutellation of *Ophisaurus attenuatus attenuatus*

| Character | M | O.R. | σ | V | N |
|---------------------------|-------------------|---------|------------------|------------------|----|
| scales around parietal | 7.10 \pm .074 | 5-10 | .700 \pm .052 | 9.9 \pm .738 | 90 |
| upper labials | 11.17 \pm .067 | 9-13 | .656 \pm .047 | 5.9 \pm .426 | 96 |
| lower labials | 7.47 \pm .076 | 6-9 | .747 \pm .054 | 10.0 \pm .718 | 97 |
| preoculars | 3.30 \pm .071 | 2-5 | .694 \pm .050 | 21.0 \pm 1.516 | 96 |
| lorilabials | 4.12 \pm .096 | 1-6 | .954 \pm .070 | 23.2 \pm 1.710 | 92 |
| loresals | 9.81 \pm .209 | 6-16 | 2.038 \pm .148 | 20.8 \pm 1.509 | 95 |
| postnasals | 1.68 \pm .047 | 1-2 | .465 \pm .033 | 27.7 \pm 1.979 | 98 |
| scales around tail | 18.29 \pm .093 | 18-20 | .665 \pm .066 | 3.6 \pm .356 | 51 |
| scales along lateral fold | 108.92 \pm .449 | 102-115 | 3.174 \pm .317 | 2.9 \pm .291 | 50 |

TABLE 3a.—Variation in scutellation of *Ophisaurus a. attenuatus*

With the exception of N, which refers to the number of specimens in the sample under consideration, the figures given below are percent.

| Separation of Prefrontals in Midline | | | |
|--|----------------|----------------------|----|
| in contact | not in contact | contact questionable | N |
| 78 | 10 | 12 | 50 |
| Contact of Uppermost Postnasal with Supercanthal Row | | | |
| in contact | not in contact | contact questionable | N |
| 2 | 96 | 2 | 48 |
| Dorsal Scale Rows | | | |
| 14 or less | more than 14 | | N |
| 100 | 0 | | 50 |

Hemipenis: The hemipenis of *O. a. attenuatus* is essentially similar to that of *O. a. longicaudus*.

SPECIMENS EXAMINED

Arkansas: Cleveland County: CNHM 49645. Drew County: CNHM 40802. Faulkner County: CM 25030. Lonoke County: CM 21547. Pope County: CM 24615.
Illinois: Champaign County: UIMNH 2081-2; UMMZ 95056. Cook County: CNHM 2971. Grundy County: CNHM 33653. McLean County: MCZ 5453, 5547-8. Wabash County: USNM 12048(3).

Indiana: CNHM 19261, 23474. Jasper and Pulaski Counties: CM 9986-8, 25885. Lake County: UMMZ 68749. White County: UMMZ 101726.

Iowa: Monroe County: CM 9776.

Kansas: USNM 9360. Allen County: UKMNH 492. Anderson County: AMNH 2677; UKMNH 485-8, 495. Bourbon County: UMMZ 66931; USNM 6073. Crawford County: UMMZ 97432. Douglas County: UKMNH 489-91, 493, 497-8, 509, 11322-7, 19281, 23605-6. Franklin County: AMNH 37358; CM 8651; UKMNH 500; UMMZ 66928-9. Greenwood County: UKMNH 17246, 17419, 16285. Jefferson County: UKMNH 20872. Labette County: UKMNH 494. Leavenworth County: UKMNH 21929. Miami County: UMMZ 66930. Riley County: AMNH 40187; UMMZ 64412.

Louisiana: Calcasieu Parish: TU 2377. Cameron Parish: UMMZ 86508(5). Jefferson Davis Parish: TU 2381-4. Lafourche Parish: TU 5446. Morehouse Parish: USNM 5129. Natchitoches Parish: UKMNH 24496. Rapides Parish: USNM 5089. Tangipahoa Parish: TU 2364. Vernon Parish: CM 23876; UKMNH 24495.

Missouri: Dent County: UMMZ 90453. Howell County: USNM 58196. Jasper County: USNM 58198. Jefferson County: USNM 99714. Lawrence County: CNHM 8755-7. Oregon County: USNM 58199. Pettis County: USNM 26314. Pulaski County: CNHM 47503. St. Louis: USNM 3193, 5131(2), 58200. Wright County: USNM 45114.

Nebraska: USNM 14076.

Oklahoma: USNM 125127. Comanche County: UMMZ 52416. Major County: USNM 99457. Okmulgee County: UMMZ 64220-1. Tulsa County: UMMZ 77572, 97426-8, 97429(2), 97430-1. Woods County: UKMNH 6615.

Texas: BCB 0067; CM 1034; MCZ 607, 625. Aransas County: CM 26041; UIMNH 12950. Bexar County: BUM 1188. Bowie County: BCB 5752; BUM 2974; UIMNH 932-3, 18969. Calhoun County: BUM 0645. Cameron County: USNM 32827. Chambers County: BCB 5599. Cooke County: USNM 14515, 15535-7. Dallas County: UIMNH 17058. Eastland County: UKMNH 508. Fort Bend County: UIMNH 12949. Gonzales County: BCB 0416, 0632. Hamilton County: BUM 6061. Harris County: BCB 5699. Hidalgo County: USNM 82303. Jefferson County: BCB 4515-6. Kerr County: USNM 32826. McLennan County: BCB 5677; BUM 1577, 6634, 6639; CNHM 53165-6, 55077. Morris County: USNM 83684. Nacogdoches County: CNHM 35040. Nueces County: USNM 3201. Smith County: BUM 5709. Victoria County: USNM 42304.

Wisconsin: Greenlake County: MPM 2448. Marquette County: MPM 2457. Sauk County: MPM 7385-6.

OPHISAURUS ATTENUATUS LONGICAUDUS McConkey

Ophisaurus attenuatus longicaudus McConkey, 1952, Natural History Miscellaneous, No. 102, p. 1.

Ophisaurus attenuatus, Neill, 1949, Herpetologica 5(3), p. 100.

Diagnosis: An *Ophisaurus* differing from other members of the genus in North America by the following characters taken in combination: the white marks on the scales occupy the middle of the scales, and the unregenerated tail of the adult is 2.4 or more times the snout-vent length.

Geographic Range: Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee and Kentucky.

Type: AMNH 71305, a male, collected June 15, 1948, by John W. Crenshaw, near the Emory University Field Station, twelve miles southwest of Newton, Baker County, Georgia. The type was formerly L32 in Mr. Crenshaw's private collection.

Description of Type: Snout-vent length 208; tail length 568 (the tail is complete except for the last one or two scales, which seem to have been broken off since preservation); head length 23.9; head width 8.4; eye diameter 4.6; dorsal scales in 14 longitudinal series; scales around parietal 7-7; upper labials 12-12; lower labials 8-9; preoculars 3-4; lorilabials 5-5; loreals 13-12; postnasals 2-2; scales around tail 18.

Frontonasal single; labials separated from orbit by lorilabials and suboculars; prefrontals in contact in the midline; uppermost postnasals not in contact with the supercanthal row; postinternasals in contact medially; five supraoculars; canthals extending to just above anterior margin of eye; frontal broad posteriorly, tapering to a point anteriorly; occipital not quite as broad as the interparietal; frontoparietal in contact with the third and fourth supraoculars; first and second upper labials in contact with the nasal.

Dorsal rows one to three with low keels, the keels becoming less distinct laterally, so that rows five to seven are flat; ear opening roundish-oval, larger than nostril; tail 2.73 times snout-vent length.

The most striking feature of the pattern of the type specimen is the cross-bars of the dorsal region. These cross-bars are usually two-scale rows wide and five-scale rows apart (longitudinally). The scales in the anterior of the two transverse rows involved in each cross-bar are generally dark brown (OOS-2-6°) on their anterior two-thirds, and whitish on their posterior third. Approximately the anterior one-fourth of the scales of the posterior row of each cross-bar is greyish-white. The remainder of each scale of this second row is dark brown (OOS-2-6°). Thus each cross-bar consists of a narrow white band bordered on each side by a dark brown one. On some cross-bars the anterior brown band includes the posterior edge of the transverse scale rows immediately anterior to the principal rows of the bar. Laterally the cross-bars do not extend past the third-scale row. Only about half of the cross-bars extend straight across the back; the others are bent or broken at the midline. The latter condition becomes predominant on the posterior portion of the body, where the bars of one side appear to alternate with those of the other. On the tail the bars become less and less distinct, and fade out entirely about one-third of the way to the tip.

The middle dorsal scale rows (row one of each side) between the cross-bars have irregular dark brown spots on their dorsal halves. The vague mid-dorsal stripe thus produced extends about two-thirds of the distance to the end of the tail.

The ground color of scale rows one to three and the upper half of row four is light brown (OOS-5-5°). The bottom half of row four and the upper one-fourth of row five are solid dark brown (OOS-2-6°), which color forms a stripe the length of the body. The middle of each scale in rows five and six is occupied by a whitish mark which runs across the scale in a longitudinal direction. The tendency is for the whitish mark to have a greater dorsoventral extent at the posterior edge of the scale, producing as an extreme case a "T"-shaped mark. Sometimes the white does not extend quite to the anterior edge of a scale; however, the overall effect is that of a white stripe running down the middle of rows five and six of each side. The lower fourth of row five and the upper fourth of row six are dark brown (OOS-2-6°), with the heaviest pigmentation concentrated in the anterior part of each scale. This produces a second lateral brown stripe, narrower and more irregular than the uppermost one. A similar, though less distinct, dark brown (OOS-2-6°) stripe is developed on the lower fourth of row six and the upper fourth of row seven. The pattern of row seven is irregular, but it tends to be dark brown anteriorly and light brown to whitish posteriorly in each scale. In summary, the lateral pattern of the type may be said to consist of three dark brown stripes separated from each other by white stripes.

The lateral pattern of the tail near the base consists of five dark brown (OOS-2-6°) stripes separated by four white stripes. The four mid ventral rows are immaculate white, except for a small brown spot on some scales just at the junction of the midventral row and the adjacent one. These brown dots suggest a sixth brown stripe. Of course, the various lateral stripes drop out with their respective scale rows as the tip of the tail is approached. On each side of the body below the lateral fold are two rows of dark brown (OOS-3-4°) spots. These are found along the junctions of rows one and two, and two and three. The spots are nearly continuous, and consequently give the effect of stripes. Except for these rows of spots, the venter is entirely greyish-white.

The ground color of the head is the same rich brown (OOS-5-5°) as the dorsum. Considerable spotting with dark brown (OOS-2-6°) is found on the posterior portion of the head. White spots are also scattered over the head, tending to be located along the sutures, whereas the brown mottlings are more frequently in the center of the scales.

Variation in Coloration: The color pattern exhibited by the type is representative of fully mature specimens of *Ophisaurus a. longicaudus*. The most striking differences between it and young specimens are the absence of transverse dorsal bars and the greater prominence of lateral stripes in young animals. A young male (ERA-WTN, unnumbered) 152 mm. in snout-vent length, from Scott's Ferry, Calhoun County, Florida, is described herewith.

A dark brown (SO-1-4°) stripe occupies the dorsal two-thirds of scale row one of each side. The ground color of the back (O-9-2°) extends through the upper one-fourth of scale row four. Laterally, the pattern is of three dark brown (SO-1-4°) stripes separated by white. These lateral dark stripes are situated as follows: upper stripe on the lower three-fourths of row four and the upper one-fourth of row five; middle stripe on the lower one-fourth of row five and the upper one-fourth of row six; lower stripe on the lower fourth of row six and the upper fourth of row seven. In addition, there is a row of spots of the same brown color on the lower fourth of row seven. Thus the middles of rows five, six, and seven are white. The lateral stripes are continuous from scale to scale and regular in width; that is, they are smooth, rather than broken as is the case in old specimens.

Below the lateral fold is a nearly continuous row of dark brown (SO-1-4°) dots, occurring at the junction of scale rows one and two. Except for this, and a few flecks of the same color at the junction of rows two and three near the anus, the venter is plain greyish-white.

The tail has the same dorsal pattern as the body. Near the base, there are four clearly defined brown (SO-1-4° to OOS-6-5°) stripes alternating with white. In addition, a narrow, partially broken brown (OOS-6-5°) stripe is present one scale row below the lower of the four lateral stripes mentioned above. The subcaudal region (four scales wide) is cream colored (OY-19-3°).

The light dorsal ground color (O-9-2°) extends to the head. Most of the large plates of the head have a roundish dark brown (SO-1-4°) spot centrally located. No white is present on the dorsal surface of the head. The lower jaw is clear white except for a few brown spots on the lower labials of the same color as those on the top of the head.

TABLE 4.—Variation in scutellation of *Ophisaurus attenuatus longicaudus*

| Character | M | O.R. | σ | V | N |
|---------------------------|-------------------|---------|------------------|------------------|-----|
| scales around parietal | 7.24 \pm .096 | 5-10 | .911 \pm .068 | 12.6 \pm .939 | 90 |
| upper labials | 11.29 \pm .087 | 8-13 | .837 \pm .061 | 7.4 \pm .543 | 93 |
| lower labials | 7.95 \pm .078 | 6-10 | .759 \pm .055 | 9.5 \pm .689 | 95 |
| preoculars | 3.57 \pm .066 | 2-5 | .654 \pm .046 | 18.3 \pm 1.301 | 99 |
| lorilabials | 4.18 \pm .106 | 1-6 | 1.021 \pm .075 | 24.4 \pm 1.799 | 92 |
| lorealis | 11.26 \pm .222 | 6-17 | 2.176 \pm .157 | 19.3 \pm 1.393 | 96 |
| postnasals | 1.78 \pm .056 | 1-3 | .558 \pm .039 | 31.3 \pm 2.213 | 100 |
| scales around tail | 18.86 \pm .147 | 18-22 | 1.048 \pm .104 | 5.6 \pm .554 | 51 |
| scales along lateral fold | 106.28 \pm .386 | 101-113 | 2.728 \pm .273 | 2.6 \pm .257 | 50 |

TABLE 4a.—Variation in scutellation of *Ophisaurus a. longicaudus*

With the exception of N, which refers to the number of specimens in the sample under consideration, the figures given below are percent.

| Separation of Prefrontals in Midline | | | |
|--|----------------|----------------------|----|
| in contact | not in contact | contact questionable | N |
| 69 | 25 | 6 | 49 |
| Contact of Uppermost Postnasal with Supercanthal Row | | | |
| in contact | not in contact | contact questionable | N |
| 10 | 66 | 24 | 49 |
| Dorsal Scale Rows | | | |
| 14 or less | more than 14 | | N |
| 100 | 0 | | 51 |

Hemipenis: The hemipenis of *O. a. longicaudus* is approximately ten subcaudals long. A single prominent, spine covered ridge runs the entire length of the organ medial to the sulcus. Another ridge about one-fourth the length of the hemipenis is located on the lateral side of the sulcus. The remainder of the organ is spinose, but the spines are longer and not so thickly set as those on the ridges. The hemipenis of a specimen from Orange County, Florida, is shown in Figure 2.

SPECIMENS EXAMINED

Alabama: USNM 67596. Baldwin County: CM 18651. De Kalb County: TU 5585, 5590. Mobile County: CM 16807; MCZ 609-10. Tuscaloosa County: DBUA 50-157. Walker County: DBUA 51-172.

Florida: CM 4307; MCZ 7045; USNM 8978. Brevard County: CM 1679; USNM 12004. Calhoun County: ERA-WTN 15010, 15017, unnumbered. Charlotte County: CNHM 35860. Escambia County: MCZ 612. Hernando County: UMMZ 98713. Hillsborough County: CM 4306. Lake County: DBUF 914, 2439; ERA-WTN 15019-20; USNM 24343-4, 69652. Manatee County: UMMZ 75670. Marion County: CM 6999, 7000; CNHM 48230-44; DBUF 3061; ERA-WTN 15001, 15009, unnumbered; UMMZ 95571(3), 95572-3. Orange County: BUM 1576; ERA-WTN 13021. Pinellas County: USNM 10336, 52212, 61038. Polk County: CNHM 25755. Volusia County: UMMZ 100674; USNM 23972.

Georgia: USNM 5038. Baker County: JWC FC192, FC219, FC598, L32, L48, S36. Baldwin County: MCZ 603. Bartow County: UMMZ 67808. Burke County:

ERA-WTN unnumbered. Clarke County: ERA-WTN unnumbered; MCZ 604. Columbia County: ERA-WTN unnumbered. Dougherty County: JWC S70. Grady County: CNHM 8088.

Kentucky: Hart County: UKMNH 19762.

Mississippi: USNM 5322. Harrison County: AMNH 57756; UMMZ 76838, 95003. Lafayette County: UMMZ 53646. Lauderdale County: UMMZ 90142B. Webster County: UMMZ 97433.

North Carolina: Bladen County: NCSM unnumbered. Iredell County: USNM 13383. Wake County: NCSM unnumbered (5). Warren County: NCSM unnumbered.

South Carolina: Aiken County: USNM 32530. Berkeley County: CM 21787. Charleston County: MCZ 616. Dorchester County: USNM 91413. Georgetown County: ChM 33.327.16. Greenville County: USNM 18024. Lexington County: CNHM 52948.

Tennessee: Bradley County: USNM 29618. Cumberland County: UMMZ 56364. Hardeman County: UMMZ 97434.5. Knox County: MCZ 606; USNM 4169(2). Roane County: USNM 14724.

Virginia: Hanover County: USNM 38508. Nansemond County: USNM 39043.

LIFE HISTORY

Since only one kind of North American glass lizard has been generally recognized up to the present time, records from the literature are largely unusable in gathering information on the ecology of the various forms. Publications pertaining to certain areas of the country where only one glass lizard occurs, such as Texas, cause no difficulty; but it is a rare paper that mentions an *Ophisaurus* from southeastern United States and gives sufficient description for me to determine to which form reference was made. For this reason all the American *Ophisaurus* will be considered together in this paper in summarizing what is known of their life history.

HABITAT

Ophisaurus ventralis (s.s.) is probably the best known of the North American glass lizards. It outnumbers all other forms in collections, and more references are traceable to it than to either of the other species. No doubt the fact that it ranges through the Atlantic and Gulf Coastal Plain is partly responsible for its being well known, since that area has in general been studied longer and better than most of the range of *Ophisaurus attenuatus*. *Ophisaurus ventralis* is the only *Ophisaurus* with which I have had direct field experience.

As far as I know, Mr. Wilfred T. Neill of Silver Springs is the only herpetologist who has made ecological observations on *Ophisaurus* in southeastern United States with the knowledge that he was dealing with more than one form. He has kindly summarized and made available to me his field knowledge of the glass lizards. He characterizes the habitat of *Ophisaurus ventralis* as follows: "common in pine flatwoods, mesic hammock, borders of low hammock, . . . damp grassy situations generally." I have seen a good number of *Ophisaurus ventralis* in the field, and my observations agree substantially with the above.

Besides Mr. Neill's observations, I am fortunate to have the field notes taken by Mr. John Crenshaw on some specimens of glass lizards in Georgia. It should be noted that Mr. Crenshaw was not aware of the existence of more than one kind of *Ophisaurus* in Georgia when he took these data. Four of the specimens referred to are *Ophisaurus ventralis*. Two of these were recorded as being from "bottomland," and one from "mesic-hydric hammock."

The fourth specimen was disturbed while sunning near a creek in "dry pine-land." This *Ophisaurus* took refuge in the water, swimming under the surface.

Mr. Neill's notes on *Ophisaurus a. longicaudus* are "turkey-oak and long leaf pine, live oak hammock, broom sedge fields; dry, grassy places generally." Four specimens collected by Mr. Crenshaw in Georgia were all associated with high pine or turkey-oak. It is interesting to note that the range of *O. a. longicaudus* in Florida apparently does not extend south of Lake Okeechobee, which is also the approximate southern limit of turkey-oak. One specimen of *longicaudus* collected by Mr. Neill in the piedmont of Georgia was "found in very dry and barren red clay field with scattered patches of broom-sedge." Aside from this record, I have no information on *longicaudus* from above the fall line, although a large part of its range lies outside the coastal plain.

Wright (1932) says that *Ophisaurus* enters gopher turtle burrows. This is very probably a reference to *O. a. longicaudus*, since the turtle customarily makes its burrow in the drier pine and turkey-oak woods.

The habitat of *O. a. attenuatus* in the west may apparently also be described as "dry, grassy places." Force (1930) mentions that glass lizards in Oklahoma are "Occasionally collected in the open during the day, in the brush and leaves about fallen trees, in a grassy field at the edge of the city. . . ." Hurter (1911) was probably referring to *attenuatus* when he said of *Ophisaurus* in Missouri, ". . . mostly found in dry meadows. . . ." Garman (1892) stated that the glass lizards in Illinois were formerly "a very common species in dry prairie regions. . . ."

The range of *O. compressus* is very disjunct, but wherever it is found, it is either associated with coastal regions, scrub associations, or the immediate vicinity of scrub. Mr. Neill found it in South Carolina "along beaches, beneath wrack or in patches of beach grasses." Besides specimens from within scrub and coastal areas, I have also seen *compressus* that were collected in flatwoods. Three specimens have been collected by Mr. Neill in low flatwoods at Burbank, Florida. However, this locality is only about five miles distant from the "Big Scrub" of the Ocala National Forest, and a smaller patch of scrub occurs within a mile. These three specimens seem to be no different from other *compressus* populations throughout the state. Mr. Neill has shown me the exact log from which one Burbank *compressus* was taken. It is located in a very low, damp flatwoods not fifty yards from a stump which sheltered two *O. ventralis*. Apparently the two species may at times occupy the same major habitat. Wright and Funkhouser (1915) describe two *compressus* and one *ventralis* from Billy's Island, Georgia; and state that all three were "found in exactly the same locality." The significance of the flatwoods population of *compressus* at Burbank must await further specimens before it may be evaluated. Broods of young from this area would be of considerable interest in regard to the taxonomic status of *ventralis* and *compressus*.

ABUNDANCE

Many discussions of glass lizards in the literature combine references to their burrowing habits with an estimate of abundance. Most authors are agreed that *Ophisaurus* burrows, but there is a wide range of opinions on its commonness. Hurter (*supra cit.*) caught two during twenty-five years of collecting in Missouri, but adds that "the farmers came across them oftener when

breaking new ground." Lönnberg (1894) says of Florida *Ophisaurus*, "not scarce in south Florida. . . . It is a burrowing animal and is therefore sometimes plowed up." Holt (1924) remarks that glass lizards in Alabama are often plowed up and considers them common. Gaige (1914) describes it as rare in Richland County, Illinois. Jopson (1940) says that *Ophisaurus* is "very common, many being plowed up in early spring," in South Carolina. Fitch (1949) records a total of seven specimens seen in 5300 miles of driving in western Louisiana. Van Hyning (1933) considers it "moderately common" and Carr (1940), "fairly common" in Florida.

Doubtlessly some of the difference of opinion regarding abundance of glass lizards is due to differences in collecting, but most of it is probably a result of the fact that different authors have been talking about different species of lizards. It may be that one species burrows more than another. In connection with this, it is noteworthy that the head of *O. attenuatus* appears to be flat on top, whereas that of *O. ventralis* is gently rounded. Thus it would seem that *attenuatus* is more fitted for burrowing than is *ventralis*.

In addition, the extent and nature of the habitat would have an influence on abundance. *Ophisaurus ventralis* lives in the dominant plant form of the coastal plain, and probably has a large continuous population throughout its range. Also, the fact that it occurs along streams, and in grassy meadows, would increase the chances of *ventralis* being encountered by humans. The turkey-oak habitat of *attenuatus longicaudus* is extensive, but not as much so as the flatwoods, and is a sparsely populated area. The scrub and dune associations which *compressus* inhabits are small and scattered, and infrequently visited by man. This could account for the rarity of the species in collections. Actually, it may be quite abundant in places; Mr. Neill tells me that *compressus* is very common under palmetto fronds on the beach at Bluffton, South Carolina.

The range of *attenuatus attenuatus* is most extensive of all the North American glass lizards, but the density of the glass lizard population is hard to estimate. Most references tend to characterize *a. attenuatus* as uncommon. It may be that the habitat suitable to *a. attenuatus* is not the widespread prairie, but the scattered woodlands within the prairie area. If that be the case, then the population could be quite dense wherever the animal actually occurs, and still seem to be sparse over the entire range.

ACTIVITY

There is some question in the literature as to whether glass lizards are diurnal or nocturnal. Smith (*supra cit.*) seems to feel that they are not normally diurnal. He says, "Specimens discovered during the day may actually be in hiding, as they are usually found concealed or are accidentally startled; there is no evidence that they have been discovered in normal activity. Carr is the only author who has reported seeing them resting in the open during the day. . . ." It is my opinion that when *Ophisaurus ventralis* comes above ground it is crepuscular. I have frequently seen specimens moving about just at sunset apparently engaged in foraging. I have also seen them sunning; in fact, in April, 1951, I found a medium-sized specimen basking on a sidewalk about half an hour before sunset. A record of one sunning in Georgia has been noted above.

I have heard that the glass lizards on the South Carolina coastal islands

(thus, *compressus*) enter the sea, presumably to pursue fish, but the author of this statement is unknown to me, and it appears to be an unlikely occurrence.

No information is available to me on the activity of either of the races of *Ophisaurus attenuatus*.

PREDATION

Schmidt (1932) lists a tail of an *Ophisaurus* that was found in the stomach of a coral snake from Gainesville, Florida. Mr. Sam R. Telford tells me that he found an *Ophisaurus* in a coral snake stomach from Winter Haven, Florida. From his description, it seems probable that it was a specimen of *Ophisaurus ventralis*. Smith (*supra cit.*) says that "in captivity king snakes have been observed to eat" glass lizards. A red-tailed hawk from Marion County, Florida, in the collection of Dr. Pierce Brodtkorb, had an *Ophisaurus* in its crop when found. CNHM 47503, an *O. a. attenuatus* from Pulaski County, Arkansas, was regurgitated by a *Lampropeltis calligaster*.

FOOD

The references in the literature to the feeding habits of glass lizards are rather uniform. Smith (*supra cit.*) gives "insects and their larvae, spiders and other arthropods, and small snails." According to Carr (*supra cit.*) "The food appears to consist chiefly of insects, small snakes, and lizards. Captive specimens are cannibalistic." Mr. Crenshaw tells me that he has fed *Leiolopisma* to captive glass lizards. Cope (*supra cit.*) gives the following discussion of the feeding habits of *Ophisaurus*. "This 'glass snake' is a rapacious feeder, living principally on the numerous Arthropoda which abound in the regions it inhabits. I took from the stomach of a specimen from Florida three ground spiders (? *Lycosa* sp.), a grasshopper, a cricket, a cockroach, a coleopterous and a lepidopterous larva, and a small snail. Its large intestine was packed with the fragments of coleoptera. It feeds readily in confinement, taking insects from the hand. If the insect is not promptly given up to it when seized, it will pull and struggle to secure it, as a dog will try to get a stick away from the hand of its master."

An *Ophisaurus* [*a. attenuatus*] from Oklahoma recorded by Force (*supra cit.*), "fed readily on grasshoppers and the soft body parts of June beetles. . ."

REPRODUCTION

Smith (*supra cit.*) has summarized the available literature on the reproduction of American glass lizards in general. A few miscellaneous data have been obtained incidentally to this study and are listed below.

Ophisaurus attenuatus attenuatus: Three females with oviductal eggs were examined. The number of eggs each contained and their respective snout-vent lengths were: 7(185), 8(233) and 11(190).

Ophisaurus compressus: A specimen from Highlands County, Florida, had four eggs in the left oviduct and was 170 mm. in snout-vent length.

Ophisaurus ventralis: Two specimens with oviductal eggs were examined. Their lengths were 179 and 174 mm.; they contained eight and ten eggs respectively.

POSSIBLE ORIGIN OF THE NORTH AMERICAN *OPHISAURUS*

It will be postulated below that at the beginning of the Pleistocene a population of *Ophisaurus* was spread in suitable habitats from Mexico to Asia. With the southward advance of the ice sheets, this population was split into two segments, and forced to retreat southward on both continents.

It is of interest to consider the effects of glacial and interglacial stages on the expansion of this population of *Ophisaurus*, which probably was largely restricted to southwestern North America at the advent of the first glacial period. Glacial periods bring about a lowering of sea level, which in this case would increase the available dispersion routes to the east for *Ophisaurus*. At the same time, migration to the north is curtailed by the lowered temperature. Whether the early Pleistocene glass lizards migrated into Central or South America is not known, but there is no evidence at hand that such migration occurred.

Interglacial periods bring about a rise in sea level, and a warm climate. The latter favors dispersion northward. Also during interglacial periods considerable quantities of glacial melt water must be carried away. Thus, swollen rivers may constitute a barrier, particularly for burrowing forms such as *Ophisaurus*. It seems likely, therefore, that most migration of glass lizards must have taken place during glacial stages along a southern Gulf Coast route.

A possible history of dispersal and differentiation of the North American *Ophisaurus* will now be presented, considering the glacial and interglacial periods in order. I recognize that alternative hypotheses may be suggested, but the one presented is the one that seems to me to account for the present observed distribution and relationships most simply and effectively.

First glacial period. Dispersion occurred along the Gulf Coast into southern United States. This is the shortest of the glacial periods, and it may be that the immigrant glass lizards did not spread far.

First interglacial period. The sea rose considerably, Florida was almost completely submerged, and most of the Atlantic Coastal Plain was under water. Probably no differentiation of any noticeable magnitude occurred in *Ophisaurus* at this time; if, indeed, any isolation had taken place at all.

Second glacial period. This and the succeeding glacial periods have been estimated at 100,000 years by Schuchert and Dunbar (1947), or roughly twice as long as the first glacial stage. Now the sea retreated and the southern dispersal route was again open. The ancestral *Ophisaurus* population continued to spread to the east. Probably during this period the entire coastal plain region of southeastern United States was inhabited. Here the most widespread habitat was of a low and damp type, different from the high, dry, grassland areas of the southwest. It seems likely that the immigrating glass lizards might begin to inhabit the dominant, available habitat.

Second interglacial period. Now glacial melt water would inhibit transfer between the eastern and western *Ophisaurus*. Also at this time, what is now central Florida was a group of islands, as shown by Cooke (1939). This would isolate another population of *Ophisaurus*. Schuchert and Dunbar (*supra cit.*) estimate the length of this interglacial stage at 300,000 years. It seems, therefore, that sufficient time elapsed for considerable differentiation to occur, particularly if a habitat change was made.

Third glacial period. At this time the ice sheets reached as far as the

Ohio River, farther south than any other Pleistocene glaciation. In addition, the sea was not lowered as far as it had been during the previous two glacial periods (see Cooke, *supra cit.*). Therefore, since the southern coastal route was not very extensive and the cold climate conditions probably extended far down the Mississippi valley, it may be concluded that dispersal into southeastern United States was not favored at this time. Consequently, differentiation of the eastern and western glass lizards could have continued, eventually producing the species *ventralis* and *attenuatus*.

Also during this period the Florida islands were united to the mainland again, and the glass lizards of those two regions must then have come into contact. However, if the island population had advanced to specific distinctness, the status of the two populations would not be affected by the contact. If the population that developed on the Florida islands is identified with the present species *compressus*, some interesting habitat relationships may be noted. First, if *compressus* evolved on a group of islands, one of the principal habitats that would be available to it would be dunes. *Compressus* today occupies such coastal areas and scrub areas within peninsular Florida. Cooke (*supra cit.*) has shown that many of the scrub areas in Florida are former dunes of Pleistocene shorelines. Thus it seems probable that the isolated population of *Ophisaurus* on the islands that were formed when the Florida peninsula submerged, developed into a distinct form which inhabited dunes and dune-like areas. Then when the seas lowered it spread with the coastline, and remained inland only where the habitat retained the dune-like character, and where it did not compete with other glass lizards.

Third interglacial period. According to Cooke (*supra cit.*) the rise in sea level at this time was not sufficient to isolate Florida. However, numerous islands were formed on the east coast. *Ophisaurus compressus* could probably be found on these islands at this time. If the east and west populations of *Ophisaurus* had already reached reproductive isolation, any contact that occurred between them at this time would have no effect.

Fourth glacial stage. At this time the ice sheets were less extensive than at any other glacial period. Thus, migration along the southern coastal route would be little affected by climate. However, if the species *ventralis* and *attenuatus* were well established by this time, it is unlikely that there would be any invasion of the habitat of one by the other form. Thus if *attenuatus* were to spread, it would have to spread into those areas of the southeast that were not occupied by other glass lizards. The most readily available habitat would then be turkey-oak woods, which are similar to the western habitat at least in that they are dry and occur on the higher areas of the coastal plain. Therefore, it seems reasonable to suggest that during the fourth glacial period *O. attenuatus* spread into the southeast, and occupied the "dry, grassy places." Differentiation probably then began between east and west representatives of *O. attenuatus*, and progressed through the Recent period to produce the two races that are now recognizable.

Recent. With the retreat of the ice both races of *attenuatus* would be permitted to spread northward as far as suitable habitats were available. *Compressus* would have some populations isolated along the east coast by the rise in sea level. *Ventralis* was probably able to occupy most of the suitable habitat before the ice melted, and hence has not recently expanded its range to any great degree.

RELATIONSHIPS OF THE NORTH AMERICAN OPHISAURUS

SCUTELLATION

Table 5 uses the data and characters of tables 1-4 to compare the various *Ophisaurus* one to another. Each form is assigned a horizontal row and a column in the table. Any one form may be compared to any other other by following the row or column of the one to where it intersects the column or row of the other. In the square at this intersection are listed the characters which were found to be significantly different in the two forms under comparison. In the upper right hand corner of each square is given the total number of characters listed in that square. A total of twelve characters was under consideration.

Table 5 shows that the three species, *ventralis*, *compressus* and *attenuatus*, are different from each other by roughly the same number of characters. The two races of *attenuatus* differ from each other in a much smaller number of characters, but they are nevertheless clearly different forms.

SIZE AND PROPORTIONS

The maximum size of the various glass lizards has been determined by averaging the snout-vent lengths of the ten largest adults of each sex of each form. The specimens were drawn from the same samples that were used in tables 1-4.

TABLE 5.—Differences in scutellation of the North American *Ophisaurus*

| | <i>compressus</i> | <i>attenuatus attenuatus</i> | <i>attenuatus longicaudus</i> |
|-------------------|---|--|---|
| | 8 | 8 | 10 |
| <i>ventralis</i> | scales around tail dorsal scale rows prefrontals upper labials (only <i>compressus</i> males) lorilabials postnasals (only <i>compressus</i> males) scales around parietal scales along lateral fold | scales around tail dorsal scale rows prefrontals uppermost postnasal upper labials lower labials postnasals scales along lateral fold | scales around tail dorsal scale rows prefrontals uppermost postnasal upper labials lower labials lorilabials loreal postnasals scales along lateral fold |
| | | 7 | 9 |
| <i>compressus</i> | | scales around tail uppermost postnasal upper labials (only <i>compressus</i> females) lorilabials postnasals (only <i>compressus</i> males) scales around parietal scales along lateral fold | scales around tail uppermost postnasal upper labials (only <i>compressus</i> females) lower labials lorilabials loreal postnasals (only <i>compressus</i> males) scales around parietal scales along lateral fold |
| | | | 4 |
| | | <i>attenuatus attenuatus</i> | scales around tail lower labials loreal scales along lateral fold |

| | | |
|--------------------------------|--------------|----------------|
| <i>O. compressus</i> | males, 157.7 | females, 166.3 |
| <i>O. a. attenuatus</i> | males, 244.5 | females, 217.2 |
| <i>O. ventralis</i> | males, 260.3 | females, 220.5 |
| <i>O. a. longicaudus</i> | males, 288.2 | females, 262.6 |

Ophisaurus compressus appears to differ from the others in that the females are larger than the males, although this deviation may be due to chance, since the sample is small.

Neill (1949) has brought out the fact that *compressus* and *attenuatus longicaudus* have longer heads than *ventralis*. To show the relative head lengths in the North American *Ophisaurus*, I have taken the body/head ratios for the specimens in the same samples used in tables 1-4, and averaged them for each sex and kind of lizard. Due to the differences in size of the various forms, this is not a strictly valid procedure; but some differences are indicated by the figures obtained, and they are, therefore, presented here with the stipulation that any conclusions based on them are subject to error.

| | | |
|--------------------------------|-------------|---------------|
| <i>O. compressus</i> | males, 7.74 | females, 8.30 |
| <i>O. a. longicaudus</i> | males, 8.39 | females, 9.19 |
| <i>O. ventralis</i> | males, 8.62 | females, 9.18 |
| <i>O. a. attenuatus</i> | males, 8.87 | females, 9.66 |

The indications are that *compressus* of both sexes have the longest heads; and that *attenuatus longicaudus* males, but not females, are also noticeably long-headed. In all four forms the males tend to have longer heads than the females.

In connection with relative head-lengths among the various glass lizards, it is interesting to consider the number of teeth. The following chart is based upon samples of ten specimens of each form. No obvious sexual differences were observed, so that the data as presented refer to the averages for males and females combined.

| | upper jaw | lower jaw | total |
|--------------------------------|-----------|-----------|-------|
| <i>O. compressus</i> | 41.2 | 37.0 | 78.2 |
| <i>O. a. longicaudus</i> | 40.3 | 37.0 | 77.3 |
| <i>O. a. attenuatus</i> | 36.9 | 32.8 | 69.7 |
| <i>O. ventralis</i> | 34.5 | 31.1 | 65.6 |

As might be expected, the two long-headed forms appear to have a definitely greater number of teeth.

Probably the best known characteristic of glass lizards is the fragility of the tail, which frequently breaks when the animal is attacked. This results in a large percentage of specimens with regenerated tail tips. Again using the samples mentioned above, I have listed below the percentage of specimens of each form that had complete and unregenerated tails.

| | | |
|--------------------------------|-----------|-------------|
| <i>O. ventralis</i> | males, 22 | females, 27 |
| <i>O. a. attenuatus</i> | males, 27 | females, 33 |
| <i>O. a. longicaudus</i> | males, 34 | females, 47 |
| <i>O. compressus</i> | males, 54 | females, 54 |

The relative length of the complete original tail also shows differences among the forms. The figures given below are tail length/snout-vent length ratios.

| | | |
|--------------------------------|-------------|---------------|
| <i>O. ventralis</i> | males, 2.11 | females, 2.12 |
| <i>O. a. attenuatus</i> | males, 2.30 | females, 2.11 |
| <i>O. a. longicaudus</i> | males, 2.68 | females, 2.58 |
| <i>O. compressus</i> | males, 2.75 | females, 2.67 |

It appears that females, except in *ventralis*, have shorter tails, and that, except for *compressus*, they break their tails less frequently than do males. There is also an indication that a long tail is less frequently broken than is a short one. This is contrary to the usual condition in snakes, where the number of specimens with imperfect tails is directly correlated with the relative length of the tail. Of course, these samples are also small, and it may be that some apparent differences are due only to chance. Any explanation of the indicated tendencies will have to await more specimens and a better knowledge of the habits of the various kinds of glass lizards.

The length of the complete and unregenerated tail of the adult has been used to differentiate the races of *Ophisaurus attenuatus*. It may be seen from the above that roughly one-third of the specimens of this species have complete tails. Of these, ninety percent may be identified by the key given on a previous page.

Bogert (1940) suggests that "the evolution of a slender tail is coupled with a shortening of the hemipenis," in snakes. This may be at least partly applicable to *Ophisaurus*, for the species with the longest and most slender tail, *compressus*, has a proportionately shorter hemipenis than the other forms; however, the species with the shortest tail, *ventralis*, has a hemipenis that is proportionately only a little longer than that of *compressus*.

VARIABILITY

If the actual history of the North American glass lizards has been similar to the hypothetical one outlined above in the section on origin, then some conclusions may be drawn as to the relative variability of the various forms. First, one might expect that *compressus*, which occurs in small, isolated populations, would be most variable, due to the Sewall Wright effect. The species *ventralis* occupies a moderately large and more nearly uniform range that has not fluctuated to any considerable degree recently, and probably exists in a nearly continuous population throughout that range. Thus, any mutations that arose would have little chance of becoming established in the population, and it may be concluded that *ventralis* should be least variable. Both races of *attenuatus* have extensive ranges, but the nature of the habitat and its distribution probably bring about populations that are smaller than the *ventralis* population, and somewhat discontinuous. Consequently, mutations that arose would have a better chance of becoming established than would mutations in the *ventralis* population, but a poorer chance than those in the *compressus* populations. In addition, *a. longicaudus* has taken up a more variable habitat than *a. attenuatus*. Therefore, *longicaudus* should be the more variable race, since, for example, a turkey-oak population of *longicaudus* might differ from a red-clay field population in some character that was advantageous to the one, and disadvantageous or of no selective significance to the other. To summarize, it seems probable that if any differences in variability are to be found among the North American glass lizards, then the order of variability from least to greatest would be as follows: *ventralis*, *a. attenuatus*, *a. longicaudus*, *compressus*.

The coefficients of variation given in tables 1-4 indicate the variability for nine scale characters in each kind of *Ophisaurus*. Little information may be obtained by studying the coefficient of variation for any one character, due to the closeness of the coefficients for the different forms. However, a cumula-

tive estimate of the variability for all nine characters may be obtained in the following manner: for each character give the glass lizard with the lowest coefficient of variation one point; the next, two points; the next, three points; and the form with the highest coefficient, four points. The postnasals must be evaluated separately for male and female *compressus*, since in that form there is a significant sexual dimorphism in the coefficient of variation for postnasals. When the total points for each *Ophisaurus* are determined the results are:

| | |
|--------------------------------|----|
| <i>O. ventralis</i> | 15 |
| <i>O. a. attenuatus</i> | 24 |
| <i>O. a. longicaudus</i> | 27 |
| <i>O. compressus</i> | 34 |

Thus, the coefficients of variation, as determined from the samples examined, support the hypothesis outlined above.

DISCUSSION

In the preceding pages the North American glass lizards have been discussed in regard to scutellation, pattern, proportions, habitat, and variability. The evidence indicates that three primary entities are recognizable (*ventralis*, *compressus*, and *attenuatus*) and that one of these is further divisible into two subheadings (which I have referred to as *attenuatus attenuatus* and *attenuatus longicaudus*).

There remains to be considered the classification of these various forms. Several alternatives are possible. They may be considered to be four species, three species made up of four races, two species made up of two races each, or four races of one species.

A generally accepted criterion for species rank is reproductive isolation, and similarly, intergradation is an indication of subspecific standing. I agree with this rule, provided that isolation is not interpreted in an absolute sense. Thus, if two forms are known to interbreed on rare occasions, I do not feel that they must be considered subspecies on that basis alone. I shall use the term "hybrid" to refer to an intermediate between two species, and the word "intergrade" to refer to intermediates between races.

If four species are present, then *a. attenuatus* and *a. longicaudus* are species, not races. That this is not so is rather clearly demonstrated by the relationship of the two groups in scutellation, pattern, habitat and variability. The major differences between them are in proportions, with lesser differences in color, and these differences break down in the region of the Mississippi Valley, where definite intergrades are known to occur.

If four races are involved, then intergrades between all the forms must occur. I have seen no specimens which I would consider to be intermediates between *attenuatus* and *ventralis*. These two animals were found to be distinctly different in nearly every character studied, and I can think of no reason to consider them subspecifically related.

Occasional *attenuatus* have been examined that show some of the characters of *compressus*. Thus ERA-WTN 15017 has two frontonasals, 15010 has two upper labials of each side in contact with the orbit, and another specimen (unnumbered, collected in October, 1949) has a partially formed second frontonasal as well as labials in contact with the orbit. All three of these specimens are from Scott's Ferry, Calhoun County, Florida. In addi-

tion, MCZ 609 (Mobile County, Alabama) has two frontonasals, MCZ 610 (Mobile County, Alabama) and MCZ 612 (Escambia County, Florida) have both a second frontonasal and two labials of each side in contact with the orbit. All of these *attenuatus* that show *compressus* characters are from Gulf Coastal areas, but all of them are outside of the known range of *compressus*. I can give no explanation for this situation. The same characters occasionally occur in other specimens outside of the known *compressus* range, but these occurrences do not exhibit any geographic uniformity. Examples of this are USNM 6073 (Kansas) which has one upper labial in contact with the orbit, MCZ 603 (Baldwin County, Georgia, located on the fall line) which has two frontonasals, and "the type of the var. *sulcatus* from Dallas, Texas, where one labial enters the orbit." (Cope, 1900.) It thus appears that what superficially seem to be intergrades between *attenuatus* and *compressus* are actually within the normal range of variation for *attenuatus*. Occasional intermediates may occur, but the frequency of such animals almost certainly is not sufficient for the two forms to be given subspecific rank.

Thus far it has been shown that *attenuatus* is distinct from either *ventralis* or *compressus*. Consideration must now be given the possibility that the North American glass lizard fauna consists of but two species; that is, that *compressus* and *ventralis* are subspecifically related.

Ophisaurus compressus was described as a race of *ventralis* by Cope, although he said that he would have regarded it as a species were it not for the existence of USNM 10584, which "has the normal form of body and tail and scales." I have seen USNM 10584 and consider it typical *compressus*. Neill (1949) has described a specimen from Charleston, South Carolina, that he considers to be an intergrade between *ventralis* and *compressus*. Neill at that time had evidently formed, on the basis of too few specimens, a list of characters that he considered characteristic of *compressus*. The characters of the specimen in question given to indicate relationship to *compressus* fall easily within the range of variation of typical *ventralis*. In addition, I have seen the supposed intergrades and am inclined to consider them good *ventralis*. This does not mean that intermediates between *compressus* and *ventralis* are not to be found. I have seen one specimen that is clearly referable to neither species. This specimen is AMNH 22803 and resembles a *compressus* in pattern on the posterior half of the body and the tail. The anterior half of the body tends toward the pattern of *ventralis*, but shows none of the characteristic green coloration of *ventralis*. The head length is contained in the body length 7.8 times, and is thus unusually long for a *ventralis*. At the same time, the body length is 190 mm., unusually large for a *compressus*. Two upper labials of each side are in contact with the orbit. Since this is the only specimen I know of that is definitely intermediate between *compressus* and *ventralis*, I feel that it must be considered a hybrid. The double frontonasal and labials in contact with the orbit also occur occasionally in *ventralis* from outside the range of *compressus*, as well as in some specimens that are geographically adjacent to *compressus*; but, as was suggested above for *attenuatus*, this probably represents normal variation, or at most, occasional hybridization, and does not constitute basis for subspecific standing.

The remaining hypothesis is that in North America there are three species and four races of *Ophisaurus*. This is the hypothesis supported by the facts brought out above.

It is important to recognize that the American *Ophisaurus*, regardless of what taxonomic rank is given them, are at the threshold of speciation. Clear cut differences are present between all the species, but many other dissimilarities occur that exhibit overlap. All the forms are evidently very closely related. The classification given in this paper is, as has been pointed out above, one of several applicable classifications; but it is felt that the arrangement used is the one that most clearly indicates the relationships of the several recognizable forms of North American *Ophisaurus*.

SPECULATIONS ON THE ORIGIN OF THE GENUS OPHISAURUS

The earliest known anguoid lizards are members of the family Glyptosauridae from the Upper Cretaceous of North America. Various members of this family are also known from the Eocene and Oligocene of North America, and from the Eocene of Europe. Darlington (1948) implies that there are anguoid fossils from Asia, but gives no definite reference to support that statement. Gilmore (1923) has shown that the North American glyptosaurids are most closely related to the Gerrhonotinae among living anguids, and it seems possible that the entire family had its origin in a glyptosaurid ancestor. This hypothesis is supported by the fact that all genera of the Anguidae are restricted to the Western Hemisphere (with the exception of *Ophisaurus*, which occurs in Asia and Europe, and *Anguis*, a monotypic genus probably derived from *Ophisaurus*, also occurring in Europe).

Tihen (1949) has shown that the northern Mexican plateau was probably the place of origin of the Gerrhonotinae. It is generally conceded that *Ophisaurus* and the Gerrhonotinae form a distinct division of the Anguidae characterized by the presence of a lateral fold, and thus it seems probable that the ancestor of modern *Ophisaurus* also developed in the Mexican plateau region. Possibly both *Ophisaurus* and the Gerrhonotinae came from a common immediate ancestor, which stock developed a branch that tended toward reduction of the limbs, and gave rise to *Ophisaurus*. That the Mexican plateau has been a center for Anguoid development is further supported by the fact that two families of Anguid derivation, the Xenosauridae and the Annielidae, are restricted to southwestern North America.

Tihen (*supra cit.*) postulates "a very early and rapid modification and spread" of the Gerrhonotinae at the beginning of the Tertiary, and also suggests that further emigration occurred during the lower Oligocene. It is not clear whether the *Ophisaurus* stock underwent similar activity during both these periods, but that it spread at some time prior to the Miocene is certain, since there are fossils from the Miocene of Europe that are definitely referable to the genus *Ophisaurus* as it is presently defined. Clearly then, the *Ophisaurus* stock spread northward, across Asia, and into Europe at some time in the early Tertiary. However, what morphological changes took place while this emigration was in progress are unknown due to the lack of fossils from everywhere except Europe.

It is certain that the *Ophisaurus* stock that spread into Europe had not completely lost the limbs, because the species found there at present, *apus*, has vestiges of the hind pair. The form found in North Africa, *koellikeri*, has similar remnants. These are the only known *Ophisaurus* with any external vestiges of limbs, and it is interesting to note that these forms, *apus* and *koellikeri*, apparently the most primitive species of the genus, are at the periphery

of the range. The only other anguid found in Europe, *Anguis fragilis*, has no external limbs and no lateral fold. However, it is thought by Camp (1923) to be more closely related to *Ophisaurus* than the latter is to the Gerhonotinae. If this be true, it is not unreasonable to suggest that *Anguis* may have arisen from the immediate ancestors of the present European *Ophisaurus*. This derivation did not necessarily have to take place subsequent to the Miocene, however. *Ophisaurus* could have been in Europe since the Eocene, even though evidence of its presence prior to the Miocene is at present lacking.

I have not had the opportunity of examining any specimens of the Asiatic *Ophisaurus*, but from the literature it appears that they are closely related to the North American forms. Two possible explanations of the relationships of the North American and Asiatic *Ophisaurus* may be suggested. First, it may be that the original stock that spread across Asia and into Europe broke into two separate populations; one retaining vestiges of the hind limbs, and the other, the Asiatic population, losing them entirely. This reasoning assumes that complete loss of external limbs occurred independently in the North American and Asiatic *Ophisaurus*.

The second suggestion is that of the original *Ophisaurus* emigrants from North America, only the European population survived; and that the *Ophisaurus* stock remaining in North America continued the trend toward loss of limbs until an entirely limbless form was developed. A second immigration into Asia must then be postulated. This would have to have occurred rather recently, perhaps at the beginning of the Pleistocene. The changing climate of the Pleistocene could then have separated the Asiatic and American populations, driving them to the south on both continents.

It should be remembered that neither of the above hypotheses is supported by fossil evidence. However, because of the apparently close relationship between North American and Asiatic *Ophisaurus*, indicating rather recent separation of the two populations, I am inclined to favor the second.

Finally, whether the Asiatic population represented a segment of a limbless *Ophisaurus* population developed in North America, or was an independently derived form, it is assumed that not more than one species of lizard was involved at the time of the establishment of each of the two populations. Subsequent evolution and emigration must have occurred in both Asia and North America to produce the three different species presently recognized in each.

SUMMARY

A systematic study of the North American lizards of the genus *Ophisaurus* recognizes four forms: *O. ventralis*, *O. compressus*, *O. a. attenuatus*, and *O. a. longicaudus*. The variation in coloration and scutellation is summarized for each form.

A discussion of the life history is presented, and the differences in habitat of the several forms are pointed out. A hypothetical history of North American *Ophisaurus* is given.

The various forms are compared with regard to scutellation, size and proportions, and variability. An attempt is made to evaluate the alternative possibilities for classification of the North American glass lizards, and it is concluded that recognition of three species and four subspecies is the only arrangement justified by the available data. The closeness of the relationships between the forms is emphasized.

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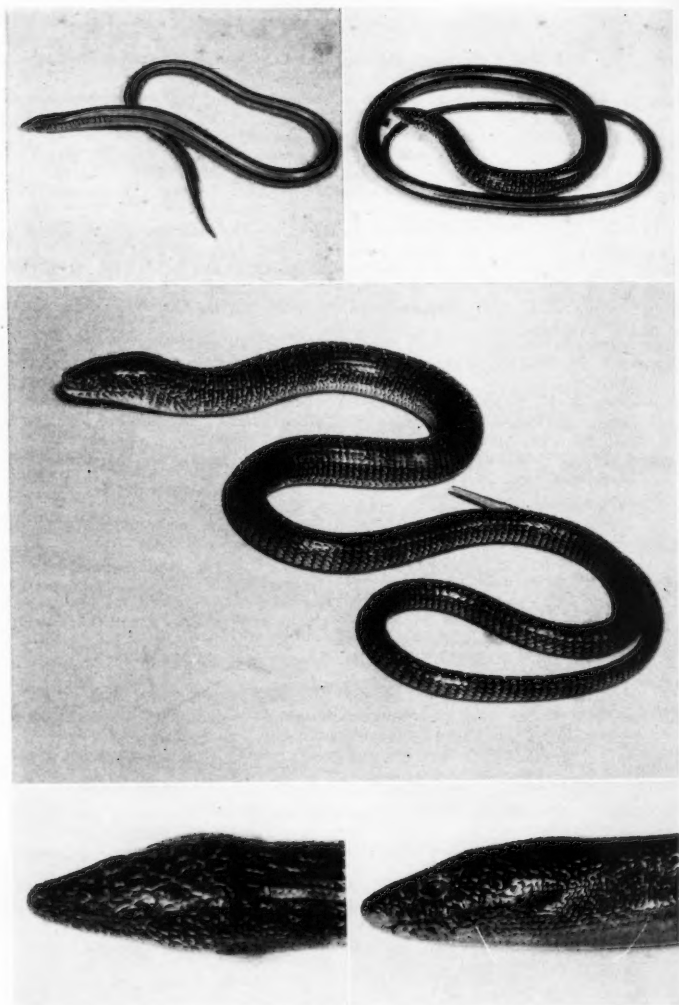


PLATE 1. Forms of *Ophisaurus* from life—Upper left: *Ophisaurus compressus*, Marion County, Florida; photo by John S. Mecham. Upper right: *Ophisaurus compressus*; Cedar Keys, Levy Co., Fla.; photo by John S. Mecham. Center: *Ophisaurus attenuatus longicaudus*; Near Chiefland, Levy Co., Fla.; A. Hyatt Verrill, collector; Photo by Mark Mooney, Jr., courtesy Zoological Society of Philadelphia. Bottom (top and side views of head): *Ophisaurus attenuatus longicaudus*; Florida (no definite locality); head-body length 278 mm. Photos by Isabelle Hunt Conant.

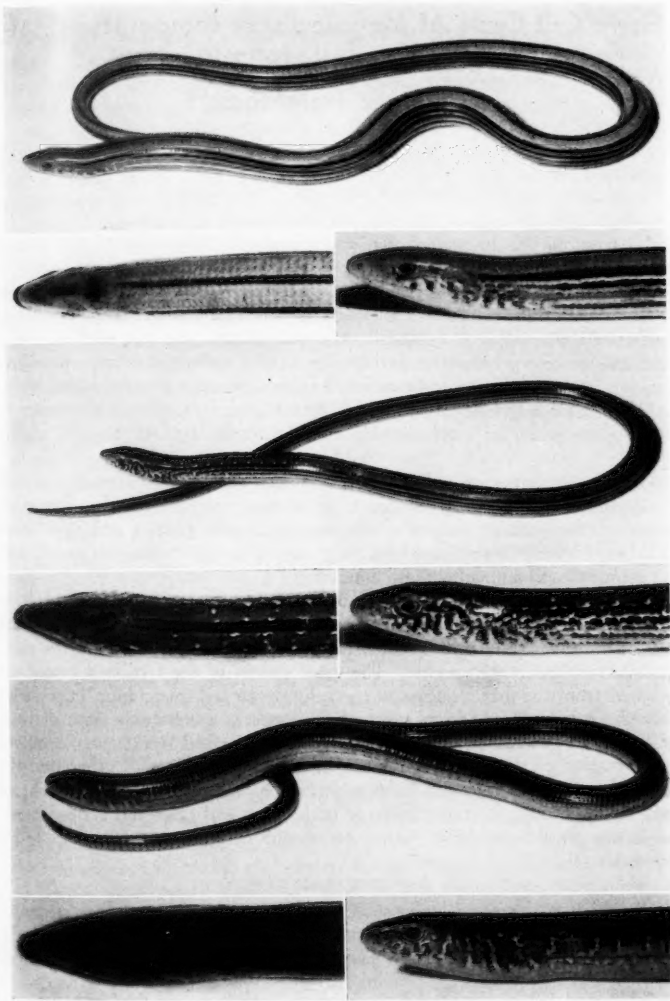


PLATE 2. Forms of *Ophisaurus* from life—Top: *Ophisaurus attenuatus attenuatus*; Alameda, Harris Co., Texas; head-body length $170 \pm$ mm.; total length $490 \pm$ mm.; Jesse Haver, collector, 1952. Center: *Ophisaurus attenuatus attenuatus*; Houston, Harris Co., Texas; head-body length $170 \pm$ mm.; total length $485 \pm$ mm.; Werner H. Gottsch, collector, 1952. Bottom: *Ophisaurus ventralis*; Savannah, Chatham Co., Georgia; head-body length $185 \pm$ mm.; total length $490 \pm$ mm.; Wilfred T. Neill, collector, November 27, 1951.

These illustrations are grouped by threes—first, the entire lizard and then (in each case) a top and side view of the head of the same animal directly beneath it. All photographs by Isabelle Hunt Conant.

Germ Cell Cycle of *Megalodiscus temperatus* (Stafford, 1905) Harwood, 1932 (Paramphistomidae: Trematoda)*

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The unique life history of digenetic trematodes has attracted the interest of many investigators ever since Steenstrup (1842) first outlined the theory of alternation of generations in digenetic trematodes. Several generations in two or more hosts are involved in the typical life cycle; the adult or egg-producing generation occurring in a vertebrate; the miracidium-sporocyst, at first a free-swimming embryo which after penetration in to a molluscan intermediate host transforms into a sac-like body; followed by one or more generations of sporocysts or rediae in the same host. In the last redial or sporocyst generation, cercariae are produced which develop into the adults after reaching the definitive host.

The many conflicting views which have been advanced to account for such a complicated life history have led to great controversy, especially since such opposite interpretations have been proposed by Brooks (1930) and Woodhead (1931). However, there have been only a few attempts to trace systematically the germinal cells throughout the life cycle of trematodes.

This investigation began with a study of gametogenesis in the adult in order to familiarize the investigator with the cytological structures of the germ cells, to ascertain the stages in the maturation process, and to obtain the chromosome number in the species. The development of the fertilized ovum was followed from the first cleavage to the fully developed miracidium in order to trace the germinal cells from which the subsequent generations were derived. In the redial generations, the germinal cells were traced from a single cell to the formation of the mature individuals, and in the last redial generation the germinal cells were followed from a single cell to the formation of mature cercariae. Through intensive study of both living and fixed and stained material it was possible to obtain a clear conception of the germ cell cycle of this trematode.

HISTORICAL REVIEW

The various theories relating to reproduction in the intermediate stages of digenetic trematodes in the molluscan host to appear in the literature were classified by Brooks (1930) into five main groups: metagenesis, heterogeny,

* Harwood (1932) showed that the European *Diplodiscus* and the North American forms possess certain anatomical differences and, thus, he felt justified in placing the North American forms in a separate genus. Since *Megalodiscus americanus* Chandler, 1923 and the North American forms of *Diplodiscus* show striking resemblances, and the differences which do exist are of specific rather than of generic value, Harwood considered *M. americanus* and *D. temperatus* to be cogenetic. Therefore, he proposed that *Diplodiscus temperatus* Stafford become *Megalodiscus temperatus* (Stafford).

Contribution of the Department of Zoology, University of Michigan and the University of Michigan Biological Station. This investigation was supported in part by a research grant from the Divisions of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

paedogenesis, extended metamorphosis, and germinal lineage with polyembryony. To this list may be added the theory of polymorphism advanced by Woodhead (1931). For a detailed review of these theories, the reader is referred to a paper by Cable (1934).

As a result of the investigations of Brooks (1930), Cable (1934), Chen (1937), and Rees (1940), the germinal lineage theory has gained more support than any of the other theories. Cort and his co-workers have been studying germinal development in the generations in the molluscan host since 1941, and their findings are in accord with the germinal lineage theory. According to this theory, the germinal cells in the sporocyst, rediae, and cercariae can be traced back as the descendants of the fertilized ovum. The germinal cells divide into somatic and germinal cells to form the embryo of the next generation. The cells of the germinal line remain distinct from the soma of the developing sporocyst or rediae, but never become true germ cells in the sense that they are localized in reproductive tissues. Reduction in chromosome number takes place only in the ovaries and testes in the adult generation.

Several early investigators described both maturation and polar body formation (Tennent, 1906; Reuss, 1903), while others reported finding polar bodies only (Haswell, 1903; Cary, 1909). More recent workers found no evidence of maturation phenomena or polar body formation in the stages in the molluscan host (Chen, Cable, Rees).

Woodhead (1931) has interpreted the life cycle of the Bucephalidae as being an alternation of three polymorphic adults with bisexual reproduction in each generation. Sporocysts and rediae are regarded as adults since they were found to possess "ovaries" and "testes" in which the germ cells undergo maturation, and fertilization occurs.

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MATERIAL AND METHODS

Adults.—Adult worms were recovered from the rectum of experimentally infested frogs, *Rana pipiens*. Others were recovered from *Rana pipiens* and *Rana clamitans* collected in the vicinity of the University of Michigan Biological Station, Cheboygan County, Michigan, and from *Rana pipiens* obtained from a supply house in Wisconsin. The younger worms proved best for the study of maturation and fertilization of the oöcytes. The larger worms with many eggs in the uterus were best for the study of segmentation of the fertilized ovum and the development of the miracidium, and for gametogenesis, in general. Testes smears were found to be of value in counting chromosomes and in studying the arrangement of spermatocyte and spermatid clusters.

Adult worms were fixed in such fixatives as sublimate acetic, Bouin's, and Gilson's, but Bouin's was found to be the most satisfactory. The alcohol drip method, normal butyl alcohol, and celloidin infiltration followed by paraffin infiltration and embedding were employed in order to reduce the amount of collapse of the eggs in the uterus. Serial sections were cut from six to ten microns; those cut at seven and eight microns proved best. Flemming's triple stain, Harris's acid haematoxylin, Mallory's triple stain, and Heidenhain's

iron haematoxylin were used. Heidenhain's iron haematoxylin without a contrast stain was used most extensively and was found to be most satisfactory for the study of chromosomes and nuclear structures. Eosin, erythrosin, triosin and fast green were helpful contrast stains for cytoplasmic structures. The Feulgen's reaction (De Tomasi modification) was used to determine the presence of chromatin in the dark bodies in the embryos and the chromatin structure in the nuclei of the oöcytes and embryos.

Miracidium.—Hatched miracidia were fixed in Bouin's, hot 10% formalin, and corrosive sublimate. The hot silver nitrate technique was employed to determine the number of epidermal plates. After this latter technique, miracidia were mounted in glycerine, or stained with Delafeld's haematoxylin and then mounted in dioxan-euparal mixture. The miracidia were also studied in the living condition using *intra vitam* staining with dilute neutral red and Nile-blue sulphate.

Sporocyst, redia, and cercaria.—These generations were fixed and sectioned within the tissues of the snail host or teased out of the snail tissues and fixed and sectioned individually. The soft parts of the experimentally infected snails were removed from the shell and fixed in Bouin's solution at five day intervals in young infections, and every eight to ten days in the older infections. The infected snail tissues were serially sectioned at six to eight microns, and stained with Flemming's triple stain and Heidenhain's iron haematoxylin with eosin or triosin contrast stains. The stages in the snail host were also studied in the living state. The shells of the snails were crushed and the tissues were teased apart carefully in normal saline. This was found to be of great value in tracing the migration of the second generation rediae as well as determining the regions of the liver occupied by the third generation rediae and the cercariae. *Intra vitam* stains such as neutral red and Nile-blue sulphate were helpful.

Observations were made with an oil immersion objective and 10x and 15x oculars, and illumination from a Spencer lamp with a 300 watt bulb. Most of the drawings were made with the aid of a camera lucida and enlarged with a universal camera lucida.

LIFE HISTORY WITH ADDITIONAL INFORMATION ON GENERATIONS IN THE SNAIL

The first account of the life history of *Megalodiscus temperatus* to appear in the literature was that reported by Cary (1909). However, Cort (1915) has shown that Cary, in his account, described two entirely different cercariae; one was a stylet cercaria developing in sporocysts and the other without a stylet developing in rediae. The second form was used in the experimental infections, but Cort further proved that this cercaria differed sufficiently in structure from the adult, that it could not possibly have developed into *M. temperatus*. Also, the cercariae used came from *Goniobasis virginea*, but there have been no substantiating reports in the literature that the cercaria of this species occurs in *Goniobasis*. Furthermore, the infection experiments carried out by Cary were not sufficiently controlled. Some time later, Krull and Price (1932) worked out the life history experimentally and reported *Helisoma trivolvis* as the only snail to harbor this parasite in the Ann Arbor area. Herber (1939) found the intermediate stages in *H. trivolvis* and reported *H. antrosom percarinatum* and *H. campanulatum smithii* as additional hosts in

Cheboygan County, Michigan. Krull and Price were able to complete the life cycle in three hosts, *Rana clamitans*, *R. cantabrigensis*, and *R. pipiens*. M. Bravo Hollis (1943) reported the occurrence of *Megalodiscus temperatus* in *Ambystoma tigrinum* in Mexico. It has also been reported from *Triturus viridescens* and from other North American species of frogs.

The cercaria is a pharyngeate, "Diplocotyle" type amphistome with pigmented eyespots. It leaves the redia when it is half grown and completes its development in the tissue of the snail. The emerged cercariae encyst on the skin of the frog, usually on the more pigmented areas. Infestation results when the frog eats its stratum corneum containing the cysts. Metacercariae escape from the cysts in the small intestine and migrate to the rectum where they attach to the wall by the large posterior sucker. The worms mature within two or three months, although eggs containing active miracidia have been found in the uteri of month-old worms in experimental infections.

Krull and Price (1932) reported only one generation of rediae in the life cycle. Herber (1938) found three rediae containing developing rediae among the cercariae-producing rediae in the livers of naturally infected snails which he considered to be first generation rediae. However, the rediae described by Herber are second generation rediae for it will be shown in the following discussion that there are at least three generations of rediae in the life history of *Megalodiscus temperatus*.

In the determination of the type of germinal development and the numbers of generations involved, it was necessary to use experimentally infected snails exclusively. Little difficulty was experienced in infecting laboratory-reared *Helisoma trivolvis*. A high percentage of infection resulted in snails four to six weeks of age, even with exposure to single miracidia. The percentage of infection dropped as older and older snails were exposed. As high as fifty percent infections were obtained when using snails two and one half to three months of age. Experimental infections were more successful during the summer months and the development of the intermediate stages more rapid. Under summer conditions, mature cercariae have been found in the snail tissues nine weeks after exposure to miracidia. During the winter months development is retarded considerably and cercariae may not emerge from the snail until three months after the initial infection. The following descriptions of the stages in the snail are based on data obtained from experimental infections carried on during the summer months.

Adult worms were removed from the rectum of the frog and placed in aquarium water at room temperature. Here they remained for five minutes while eggs containing active miracidia were released. The newly emerged miracidia were placed singly or in numbers up to 15 in dishes containing the young snails. Penetration was immediate. During penetration, it was noted that the cilia and epidermal plates of the miracidium were retained. The miracidium bores its way through the snail tissue with the aid of the anterior papilla, the contents of the two pairs of penetration glands, and by the elongation and contraction of the body. The cilia at the anterior end beat vigorously while those on the posterior half of the body show only spasmodic motion. Epidermal plates and cilia could still be clearly seen on miracidia in snail tissues fixed five hours after penetration. Twelve hours after penetration, the glands have emptied and the epidermal plates, still exhibiting a few cilia, have begun to absorb water and appear as hemispherical vesicles (fig. 78). A

similar change in the epidermal plates was found by Thomas (1883) in the miracidium of *Fasciola hepatica*. The presence of cilia and epidermal plates after penetration was also noted by Maldonado and Matienzo (1947) for *Schistosoma mansoni*. In *Fasciolopsis buski*, Barlow (1925) found that the epidermal plates and cilia were sloughed off during penetration.

After twenty-four hours, the miracidium had migrated to the wall of the stomach where it had rounded up into a clear elliptical mass. In cases where snails were exposed to a large number of miracidia, as many as thirteen masses have been counted on the stomach wall. However, even after heavy exposures, only one or two sporocysts develop. The miracidium-sporocyst serves only to bring the next generation, a single redia, into the proper host and to protect and nourish it during its early development. With the rapid growth of the first generation redia, the sporocyst becomes stretched into a thin-walled sac devoid of miracidial structures. The sac finally disintegrates after the escape of the active first generation redia at about the seventeenth to nineteenth day.

First generation redia.—Never more than one redia has been found in the sporocyst. The two-day-old sporocyst still possesses remnants of the epidermal plates and the lateral papillae of the miracidium. The redial embryo has developed to a stage where germinal cells fill the posterior half of its body and the soma cells show signs of differentiation to form pharynx and gut (fig. 71).

By the seventh day of infection, the first generation redia fills the entire sporocyst and measures 0.095 mm x 0.065 mm. A lumen appears in the pharynx and also between the two rows of cells making up the wall of the gut. A small body cavity forms behind the posterior tip of the gut and in it lie two- and three-cell embryos. Behind these embryos are nine or ten germinal cells. One of the dividing cells showed eighteen rounded chromosomes at the equatorial plate when stained with dilute Schneider's acetocarmine stain (fig. 77).

At eleven days, the posterior end of the sporocyst is thick and tapering while the remains of glands and primitive gut are still visible at the anterior end. The sporocyst measures about 0.160 mm x 0.120 mm. The body cavity of the first generation redia has enlarged and contains a few small embryos, held in place by strands of connective tissue. More of the germinal cells have divided into two- and three-cell embryos but a group of germinal cells still remains in the posterior tip of the redia. The pharynx is well developed and the gut extends back to the posterior pair of appendages which have recently made their appearance. Two pairs of flame cells can be seen: one pair in the anterior half and the other pair in the posterior part of the body (fig. 74).

By the fourteenth day of infection, the two pairs of appendages are well formed and active, and the cuticle is thick and possesses nodular protuberances and concentric rings produced by the underlying musculature. An average of sixteen embryos, varying from large ones in the anterior portion of the body cavity to progressively smaller ones at the posterior end of the redia, are present. A cluster of ten to twelve single germinal cells are grouped in a mass at the tapering posterior tip of the redia (figs. 76, 79). The sporocyst becomes a thin-walled sac (fig. 76, sp).

Between the seventeenth and nineteenth days of infection, the first generation redia breaks out of the sporocyst membrane, but, as yet, no second generation rediae have escaped. About thirty-five to forty embryos fill the body

cavity and appendages of the first generation redia, and only four or five single germinal cells remain at the posterior tip. The germinal cells are gradually being used up in the formation of embryos of the next generation. In the twenty-one-day infections, forty to forty-five embryos and only one or two germinal cells are present in the first generation redia. This marks the limit of the redial production in the first generation redia (fig. 108).

The oldest first generation redia found was 64 days old. Snails examined at 70 and 77 days after infection contained no first generation rediae. The oldest first generation redia still contained six well developed rediae and a number of medium to small size embryos, but no single germinal cells. With one exception, the first generation redia was always found in the lymph space near the stomach.

Second and third generation rediae, and cercariae in the liver.—Second generation rediae begin to escape from the first generation redia about 24 to 26 days after infection. These rediae possess well developed pharynges, guts and appendages, and in the body cavities lie a few embryos and masses of germinal cells extending to the posterior ends. One redia at a time escapes from the first generation redia and migrates to the distal tip of the liver in the apical whorl of the snail where it begins to feed. In the liver, the second generation rediae exhibit a gradation in size: the first to escape being the largest and possessing a dark brown gut while the most recent to migrate is much smaller and has a pale yellow gut. This indicates that the emergence of second generation rediae continues over a relatively long period of time.

From eight to ten second generation rediae are present in the liver between 30 and 40 days after infection, and at 50 to 60 days they number around sixteen. The recently emerged third generation rediae have begun to migrate toward the proximal portion of the liver. The germinal elements in the newly emerged third generation rediae is similar to that found in the second generation rediae (fig. 75).

The liver in the apical whorl of the snail is crowded with second generation rediae in 64 to 80 day old infections while the rest of the liver is being filled with third generation rediae. A small number of maturing cercariae are present at this time. In snails harboring the infection for three and one half to four and one half months, the entire liver is filled with rediae and cercariae. At this time, the oldest second generation rediae have just about completed their active production of rediae and some already show signs of disintegration, while the more recent arrivals are in their active period of germinal production. Since third generation rediae are emerging from the second generation rediae over a long period of time, there is a gradation in size varying from the newly emerged to large rediae containing well developed cercarial embryos in infections as old as six months.

Cercariae leave the rediae while still immature and continue their development in the tissues of the host. At that time, the oral sucker and intestine may be distinguished and the germinal cells have segregated into three groups (fig. 107). In the tissues of the snail, the eyespots appear, the tail elongates, the suckers and intestine become more developed, and the reproductive system appears. Cercariae have mature spermatozoa in the testes when they leave the snail host.

In experimental as well as in natural infections, cercariae and rediae were never seen developing together in any of the redial generations, and no more

than three generations have been found with certainty. The fact that Krull and Price (1932) found only one generation of rediae and Herber (1938) two generations in natural infections, seems to indicate that snails acquire their infection at an early age and that the infection remains throughout the life of the snail.

SPERMATOGENESIS

The two round, subequal testes are situated in the anterior half of the body, the posterior one extending back to the middle of the body. The developing germ cells are closely packed with groups of primordial germ cells and spermatogonia forming a distinct zone around the periphery of the organ.

Spermatogonia.—The primary spermatogonia lie in small groups along the thin testicular membrane (fig. 1). The nucleus, 5 to 7 microns in size, contains one or two nucleoli embedded in a dense chromatin reticulum and is surrounded by a small amount of cytoplasm. Prior to division, the spermatogonia increases slightly in size and becomes freed from the tunica of the testis (fig. 7). Typical mitotic stages may be traced during the division process to form the secondary spermatogonia (figs. 4, 5, 7, 8). The daughter cells are slightly smaller than the primary spermatogonia (fig. 10), but as they begin to divide some growth accompanies their division. Both cells enter the mitotic phases simultaneously and produce a four-cell cluster of tertiary spermatogonia (figs. 6, 13). Division in the four cells is similar to that observed in the primary and secondary spermatogonia. Eighteen chromosomes pass to each of the resulting eight cells. Thus far, all divisions have been mitotic. The rounded mass of eight cells usually lies toward the center of the testis, but figure 12 represents a group which was crowded near the periphery of the organ and all of the cells were lying in the same plane. The subsequent history of the eight-cell cluster shows them to be primary spermatocytes. The cells of the cluster are connected with each other by cytoplasmic strands radiating from a common center giving the mass a rosette appearance (figs. 17, 20, smear preparations).

Pre-synaptic stages.—The nucleus of the primary spermatocyte remains for a time in the resting condition as in the spermatogonia, but then enters a more diffuse state with the chromatin clumping in a manner to suggest spireme formation. This becomes more evident as the chromatin takes the form of fine leptotene threads, somewhat polarized, while the nucleolus migrates toward the nuclear membrane (fig. 2). As the leptotene threads become more polarized, the typical bouquet stage is formed. The number of loops could not be counted with accuracy because of their intertwining and length. However, more than the haploid was counted.

Synaptic stage.—Pseudoreduction by parasynapsis takes place in the primary spermatocytes while the chromatin material is in the prophase. During the process, the leptotene loops become shorter and thicker and are even more distinctly polarized. The nucleolus appears at one end of the nucleus, almost touching the nuclear membrane. A few free ends of the loops can be seen, but most of them either lie above or below the nucleolus and are thus lost to view. This gives the impression that the loops are spinning out from the nucleolus itself. Synapsis starts at the free ends of the loops close to the nucleolus and continues along their length. A brief amphitene stage may be observed in which the ends of the loops have fused, but with most of the lepto-

tene threads still distinct. Gradually the threads become shorter and thicker and fewer in number.

Post-synaptic stages.—With the completion of synapsis, the pachytene loops become shorter and thicker. The number of loops is definitely less than the diploid number, although it was difficult to make an accurate count.

The pachytene stage is quickly followed by the diplotene in which the loops separate slightly and the duality of the threads becomes apparent. The chromomeres arranged along the length of the threads are more basophilic in regions where the separation is not quite completed (fig. 3). The diplotene threads are at first diffuse and less basophilic, but as they shorten, thicken, and twist to form the bivalents, the basophilic condition returns. The process of diakinesis is soon completed and the bivalents appear as typical, compact, deeply-staining bodies. In late prophase and metaphase, the tetrads are in the form of rings and crosses (figs. 14 a, b, c; 17). The nucleolus has disappeared completely by the time the tetrads line up in the equatorial plane.

In preparation for the first meiotic division, the spindle forms across the broad end of the cell so that the daughter cells will also possess the cytoplasmic strands which held them together to form the rosette cluster (fig. 20). As the individual chromosomes are drawn toward the poles, a longitudinal split may be seen in some of them. In the telophase stage, the daughter nuclei appear as solid masses of chromatin. At the completion of the cytoplasmic division, the nuclear membrane reappears and the chromatin goes into a diffuse state, but does not enter a true resting stage. Basophilic strands and clumps of chromatin then appear and the spireme begins to spin out. The spireme threads then condense into small deeply-staining chromosomes which are round, oval or dumb-bell shaped in the late prophase (fig. 16). Each cell in the secondary spermatocyte cluster of sixteen cells contains nine chromosomes. As the chromosomes line up on the spindle, they elongate and resemble V's and J's as they are drawn toward the poles (fig. 19 a, b, c). In late telophase, the daughter chromosomal masses take on the form of crescents with a few ends of the chromosomes extending from them (fig. 25 a, b, c). This division results in the formation of a rosette cluster of thirty-two small spermatids, each containing nine chromosomes. The spermatid contains half the mass of the secondary spermatocyte, and the latter in turn, is half that of the primary spermatocyte. Divisions have occurred in such rapid succession that little growth has been possible. With the completion of the homeotypic division, the chromatin becomes reorganized into typical resting stage nuclei with a nucleolus in each (fig. 21).

Transformation.—The first change in the transformation of the spermatid is the elongation and the tapering of one end of the nucleus (fig. 27). The tapered end pushes against the portion of the cell membrane opposite the cytoplasmic strand, indicating the beginning of the formation of the tail. The nucleus then begins to taper at the other end to produce a spindle-shaped structure in which the chromatin is dense, but still vesicular in nature (fig. 23). While the tail portion elongates as a fine thread, the other end tapers more and more and soon begins to coil (figs. 22, 26). These coils are directed toward the center of the cytoplasmic mass and are later determined to be the anterior ends. The cell boundaries within the mass begins to disappear and the orientation of the spermatozoa is such that, in sections, all of the tails are running in the same direction (fig. 26). The coiling and then the uncoiling

of the spermatozoa may be seen in figures 15, 18, and 24 taken from smear preparations. As the spermatozoa mature and become active, they leave behind a residual mass of cytoplasm in which they developed. The freed spermatozoa arrange themselves in bundles in the testicular spaces.

Abnormalities in the testes.—In several adults, abnormal cells were found in the testes. Most commonly these were large cells, usually in groups of three to five, identical with the oöcytes found in the anterior half of the ovary (fig. 48). No spermatozoa were observed in the cytoplasm of these cells, but nuclear organization of certain cells such as represented in figures 45 and 46 suggest that fertilization might have taken place. The tetrads of these cells show signs of disintegration or doubling of the haploid number. Other abnormal cells are represented in figures 38 and 39. Cells resembling the female germ cells have also been found in various stages of disintegration.

OOGENESIS

Ovary.—The ovary is a globular sac-like structure situated in the posterior half of the body. The germ cells in it vary in size, structure, and position. The least differentiated cells, the oögonia, are usually located close to the ovarian membrane in the posterior half, but clumps of oögonia have been found deep in the organ among the primary oöcytes. Since most of the cells are in a resting stage, only a few mitotic figures of the last oögonial division can be observed in any one ovary. Young primary oögonia in the pre-synaptic and synaptic stages of development are found in the posterior portion of the organ while the rapidly growing primary oöcytes fill the anterior half. Those closest to the opening of the oviduct have reached their maximum size and measure 0.0435 mm by 0.0225 mm.

Gonial stages.—In the cercaria the oögonia have just begun to differentiate and increase in number while the testes are already producing spermatozoa. The primary oögonia are spindle-shaped cells with a small amount of cytoplasm surrounding a spherical to oval nucleus which contains one or two darkly staining nucleoli embedded in a chromatin network (fig. 44). The gonial cells divide by mitosis (figs. 30, 33, 40, 41), and continue to do so throughout the life of the adult, for mitotic figures can still be found at the posterior end of the ovary in old worms. The oögonia in the adult ovary, which are undergoing their last division in preparation for meiosis, are slightly larger and more rounded than the cells in the developing ovary of the cercaria (fig. 29).

Pre-synaptic stages.—The nuclear material of the newly formed oöcytes becomes diffuse and the granules are arranged in such a manner as to suggest a spireme. The chromatin material soon resolves itself into fine leptotene threads which appear as more or less polarized loops (fig. 34). The number of loops could not be counted accurately but appear to be more than the haploid number and it is possible that each loop represents a single chromosome.

Synapsis.—With the pre-synaptic shortening of the loops in the leptotene stage, polarization becomes more evident and the typical bouquet stage results. The leptotene threads then begin to synapse, first at their polar ends; that is, the free ends of the loops close to the nucleolus. Synapsis continues along the length of the loops until the replacement of the leptotene by the pachytene threads is complete (fig. 36). Synapsis and the shortening and thickening of

the loops appear to take place synchronously, and it is accompanied by growth of the oöcytes.

Post-synaptic stages.—The pachytene threads show no sign of duality, but as soon as they begin to spin out into longer threads to fill the entire nucleus, the longitudinally doubled appearance gradually becomes evident (figs. 31, 35, 42). The basophilic chromomeres appear serially aligned along the spireme threads. This is the diplotene stage which may be found in considerable numbers in the posterior half of the ovary (fig. 42). The loops gradually lose their basophily and diffuse slightly to form a reticulum with basophilic clumps remaining in the less diffuse regions (fig. 43). The amount of cytoplasm in the oöcyte increases as the chromatin continues to go into a more diffuse condition, giving the general appearance of a resting stage. However, the remains of what appear to be diplotene threads have been observed in the growing primary oöcytes (fig. 32). This condition has also been found in material in which the Feulgen method was employed. After synapsis, growth is so considerable that the oöcytes are several times the mass of the oogonia from which they were derived. Nucleoli are present in all of the above stages but vary in size. During pre-synaptic and synaptic stages, the nucleoli are highly basophilic and of small size, while during the post-synaptic stages they enlarge greatly, but at the same time become less basophilic. As early as the pachytene stage, a small dense cytoplasmic mass makes its appearance near the nucleus in the denser cytoplasmic region of the oöcyte (fig. 36). As the primary oöcyte approaches its maximum size, the darkly staining mass has increased considerably (fig. 37). Also, what appear to be filamentous strands outline the peripheral region of the denser cytoplasm. After fertilization, the cytoplasmic mass disappears, but the filamentous strands can still be seen after several cleavages.

Fertilization and polar body formation.—The anterior end of the ovary contains the full grown "resting oöcytes." They are polyhedral to ovoid in shape, depending upon how closely they are packed in the ovary. The oöcytes near the oviduct are spherical because they are unrestrained by pressure. The large nucleus contains a darkly-staining nucleolus lying in a fine chromatin reticulum, and the cytoplasm is divided into an inner dense endoplasm and an outer clear ectoplasm. Being liberated singly, the oöcyte passes through the oviduct into an expanded portion where the spermatozoa cluster around it as it proceeds into the oötype where the vitelline cells surround it and the shell is added. The acidophilic globules in the vitelline cells suddenly disappear as the shell is formed. Many spermatozoa can be found in one egg, but never more than one has been seen in the cytoplasm of the oöcyte. The nucleus of the oöcyte is still in the resting stage when the entire filamentous spermatozoön enters (fig. 47). As the spermatozoön shortens and takes a position near the nucleus, the chromatin of the oöcyte passes through the fine and coarse spireme stages and finally shortened irregularly shaped chromosomes appear (fig. 49 a, b). The nuclear membrane disappears and the tetrads form (fig. 51 a, b). The nucleolus gradually disappears and by metaphase no trace of it can be found (fig. 52). The spermatozoön has condensed into a compact mass lying to one side of the spindle. As division proceeds, the nine bivalents begin to separate (fig. 50), and the first polar body pinches off (fig. 53 b). The bivalents left in the oöcyte are oval, and without the intervention of the formation of a vesicular nucleus, they begin to line up on the equatorial plate in preparation for the homeotypic division. The univalents elongate, and as

they are drawn toward the poles, they take on the form of V's and J's. Nine chromosomes are cast off in the second polar body (fig. 55 b). Meanwhile, the first polar body has been freed from the oöcyte and floats freely among the degenerating vitelline cells (fig. 55 a). During the formation of the second polar body, the chromatin of the spermatozöon becomes organized into a mass of rounded chromosomes (fig. 55 c). The monads left in the ovum become diffuse and go into a vesicular form, the nucleolus reappears and both are surrounded by a nuclear membrane. This is the female pronucleus. The spermatozöon chromatin reorganizes into a resting stage nucleus and lies beside the female pronucleus (fig. 58).

Union of the pronuclei.—Fusion of the pronuclei takes place while the eggs are still in the uterus. The ovum is surrounded by fourteen to sixteen vitelline cells (fig. 58). Each pronucleus contains a large nucleolus surrounded by a fine radiating network on which are arranged dense clumps of chromatin. The pronuclei fuse to form a large irregularly shaped nucleus with two nucleoli (fig. 56). The chromatin of ovum and spermatozöon are thus mixed, and in the late prophase, the spireme threads condense to form chromosomes (fig. 60). The chromosomes line up on the equatorial plate in preparation for the first cleavage (fig. 54). As the chromosomes are drawn toward the poles, they take on the form of V's, J's, and rods, depending upon the point of attachment of the mantle fibers (fig. 57). The first cleavage gives rise to two cells of unequal size (fig. 59 a, b).

Discussion.—Gametogenesis in *Megalodiscus temperatus* is similar to that described in other digenetic trematodes. The diploid number of chromosomes is eighteen and nine chromosomes appear in the mature gametes. The number sixteen listed by Britt (1947) from Cary's work is incorrect as shown by Cort (1915).

Variations exist in the history of the pronuclei prior to the first cleavage. In *Brachycoelium salamandrae*, von Kemnitz (1913) stated that the pronuclei fused before the first cleavage since there were two nucleoli present. Cable (1931) reported pronuclei of equal size, but Markell (1934) noted that the male pronucleus was smaller. Both noted that the fusion nucleus was in a resting stage before the first cleavage. Rees (1939) found that the pronuclei formed at about the same time and remained in a resting stage for a while before fusion. Chen (1937) found that the pronuclei, after fusion, pass into a resting stage before entering the prophase of the first cleavage. In *Macravestibulum kepneri*, Jones, Mounts, and Wolcott (1945) found that the pronuclei enter a prophase before their union, and the chromosomes pass directly to the metaphase stage of the first cleavage mitosis. Willey and Koulisch (1950) found pronuclei in both resting and prophase stages prior to fusion in *Gorgoderina attenuata*. In *M. temperatus*, the pronuclei appear simultaneously and remain in a resting stage for a time. The fusion nucleus with its two large nucleoli passes into a resting stage before entering prophase of the first cleavage division.

The first cleavage has been described as unequal by Goldschmidt (1902), Schubmann (1905), Ortmann (1908), Ishii (1934), Watanabe (1934), Bennett (1936), Chen (1937), Rees (1939), Willey and Godman (1951), and Willey and Koulisch (1950). The first two of the above mentioned investigators considered the unequal size of the centrosomes to play a part in

this type of division. There appeared to be no appreciable difference in the size of the centrosomes during the first cleavage in *M. temperatus*.

Granular masses have been described in the cytoplasm of the oöcytes to which workers have ascribed various functions. Schellenberg (1911) found darkly staining granules in the oöcytes of *Fasciola hepatica* which he regarded as yolk. Cable (1931), Chen (1937), Woolcock (1935), and Markell (1943) considered the granular masses to be reserve food material. Markell (1943) noted that the granules increased in volume and were, therefore, secreted into the cytoplasm of the oöcytes to serve as reserve food. Willey and Koulisch (1950) noted a similar increase in size of the mass and came to the same conclusions. A similar condition was noted in *M. temperatus*. Pennypacker (1940) suggested that the cytoplasmic granules might be related to the nucleus.

No degenerating cells or nuclei, as described by some of the earlier workers or by Anderson (1935), which might serve a nutritive function, were found among the growing oöcytes in *M. temperatus*.

The designation by many workers that the first meiotic division is one of reduction is based on conjecture. As pointed out by Carothers (1926) the distribution of chromosomes in pseudoreduction is accomplished by two maturation divisions which act as a unit with segregation occurring in either division.

DEVELOPMENT OF THE MIRACIDIUM

The miracidium develops to maturity while the eggs are still in the uterus. The younger segmentation stages are at the proximal end of the uterus, and progressing to the distal end the development is more advanced.

Cleavage.—The cleavage of the zygote gives rise to two cells of unequal size. The nucleus of the larger blastomere is lightly staining with an irregularly shaped nucleolus, while the nucleus of the smaller blastomere consists of knots of chromatin lying along a fine network radiating from a deeply staining nucleolus. The larger cell will be referred to as the "ectodermal" cell and the smaller one the "propagatory" cell, the same terms used by Ishii (1934), Chen (1937), and Rees (1939, 1940).

Only the ectodermal cell is involved in the second cleavage (figs. 59 a, b; 61 a, b). The resulting daughter cells are similar in appearance and slightly smaller than the propagatory cell (fig. 62). The succeeding divisions affect only the cells of the ectodermal line. About the six-cell stage, four types of cells may be seen; namely, the propagatory cell, one type with a nucleus composed of a dense chromatin reticulum without a nucleolus, another with a small nucleolus, and still another with a large nucleolus and small knots of chromatin on radiating strands extending from the nucleolus to the nuclear membrane (fig. 63). The cytoplasm of the last three types is less granular than the propagatory cell. At a later stage, one of the cells of the third type begins to separate from the embryonic mass (fig. 64 a). It divides several times and the resulting cells flatten and migrate around the embryo to form the vitelline membrane which eventually comes to lie against the inner surface of the egg shell. The remaining cells of the embryo form a morula-like mass with the propagatory cell occupying much of the space (fig. 64 b). The ectodermal cells continue to divide rapidly and will produce much of the soma of the miracidium.

Embryo.—At about the eight- to ten-cell stage, the propagatory cell divides slightly unequally. The larger cell resembles the original propagatory cell while the smaller one has an appearance similar to one of the larger ectodermal cells in that it possesses a clear nucleus with a large irregularly shaped nucleolus (figs. 64 b, p_1 ; 66 a, p_1). Both cells divide simultaneously but in a different fashion at about the fifteen-cell stage (fig. 65). The smaller cell divides equally and the daughter cell nuclei consist of a few densely staining chromatin knots and small nucleoli (fig. 66 a). In the twenty- to thirty-cell stage, the cells of this line (mesoderm?) may still be seen close to the propagatory cell, but after repeated divisions, become lost among the ectodermal cells and may give rise to muscles, glands, parenchyma, and excretory structures (figs. 66 a, b; 69 b, p_1). The larger propagatory cell, however, divides so unequally that one of the daughter chromosomal masses is surrounded by so little cytoplasm in the telophase stage that it resembles a polar body pinching off (figs. 65, 67 b, 68 b). This newly pinched off chromatin mass rounds up and is surrounded by a clear area. It is difficult to determine whether cytoplasm actually surrounds it. This small cell contains the diploid number of chromosomes and there was no evidence of maturation phenomena in the larger propagatory cell. These small cells, therefore, cannot be interpreted as polar bodies. Because of the very unequal division of the propagatory cell, it appears that the daughter cell does not receive enough cytoplasm to make it a functional cell. Thus, the nuclear material is extruded from the embryo mass and floats among the granular remains of the vitelline cells where it will be resorbed.

In examining some of the older embryos, several of these deeply staining bodies or cells were seen outside the embryo but others were scattered among the cells of the embryo itself. When these bodies were first observed they were thought to be the result of the type of fixation or represented metabolic products of the embryos. However, following the various types of fixation and staining, these bodies were always found in the embryos within the eggs of large as well as small worms. In fact, there is a definite series of color changes in the bodies outside the embryo ranging from intensely staining to very faintly staining chromatin which indicates a breakdown and resorption of these bodies. Schubmann (1905) and Goldschmidt (1905) included these bodies in their figures of the embryo of *Fasciola hepatica* and *Zoögonus mirus*, respectively, and called them metabolic products in the form of chromatin globules. Tennent (1906) considered them to be lipid material. They have also been observed by other workers. The Feulgen method reveals these bodies to be composed of chromatin in a fine reticulated condition. This is further proof that they are of nuclear origin, perhaps pyknotic nuclei, and not true metabolic products.

These bodies make their appearance at about the twelve- to fifteen-cell stage, the same time at which the propagatory cell divided in so unequal a fashion. Since these bodies appeared to be more numerous in the older embryos, counts were made of the ratio between the number of cells of the embryo and the number of dark bodies to see if they resulted wholly from the unequal division of the propagatory cell. Tracing the nuclei through sections made counting difficult and some of the nuclei may have been counted twice. Nevertheless, the formation of the bodies could not be attributed to the unequal divisions of the propagatory cell alone because the ratio was too high. It was further observed that not all of the bodies inside the embryo

have a fate similar to those which were cast out. In fact, many represented newly formed daughter cells in which the chromatin had not yet entered the typical resting stage condition of the nucleus. This may be especially true of some of the bodies which have not yet rounded up but appear tapered at one end as though they had just completed the telophase stage (figs. 67 b; 68 b; 69 a). Other bodies appeared more vacuolated, representing a phase in the process of nuclear reorganization. This is probably the fate of most of the dark bodies or what appear to be pyknotic nuclei, since at a certain stage of miracidial development; namely, at the time of elongation and tissue differentiation, practically all of the bodies have suddenly disappeared. It may be that these bodies or cells are going to form a particular tissue of the miracidium. It may be mentioned at this time, that similar bodies have also been observed in the developing rediae and cercariae.

By the forty-cell stage, the outlines of the cells have disappeared completely and the limits of each cell can be determined only by the lighter staining peripheral cytoplasmic regions which surround the more granular cytoplasm of the cells. At this time another type of cell can be distinguished near the future anterior end of the embryo. It is a large cell with a clear nucleus containing a darkly staining nucleolus and a lightly staining mass of chromatin (figs. 67 c; 69 a, pg). The cytoplasm is of a fine granular nature. This cell divides several times and the resulting four cells will give rise to the primitive gut which is a large granular sac extending from the anterior papilla almost to the posterior tip of the mature miracidium. Their nuclei are round with a conspicuous nucleolus and a lightly staining mass of chromatin lying along the nuclear membrane in the maturing miracidium (figs. 70, 72 pg). The oval nuclei around the periphery of the embryo belong to those ectodermal cells which form the epidermal plates of the miracidium (fig. 70, ep). With the growth and elongation of the embryo, these superficial cells become ciliated and flattened, and are arranged in four tiers around the miracidium. There are six epidermal plates in the first tier located behind the anterior papilla, eight in the second tier, four in the third, and two covering the posterior end of the miracidium. The nuclei of these plates are oval at first, then they flatten and elongate, and finally, in the mature miracidium, they appear dendritic. Coe (1896) showed the nuclei of the epidermal plates of *Fasciola hepatica* as being elongate and slightly dendritic. Leuckart (1882) reported that for the same species they were round flat bodies one third to one fourth the diameter of the cell itself.

After each unequal division, the cytological features of the propagatory cell remains unchanged except for a reduction in size (fig. 69 b). By the time that the miracidium is half grown, the propagatory cell has ceased to divide in an extremely unequal fashion and lies in the posterior half of the embryo. It was not possible to determine just how many times the propagatory cell divided. Around this propagatory or germinal cell are some of the cells derived from the smaller cell (p_1) which resulted from the first division of the propagatory cell (figs. 69 b, 70, 72, 73). The nuclei of these cells are clear with only a few knots of chromatin and a nucleolus in each. The cytoplasm stains a bright pink with eosin, similar in intensity to that of the penetration glands at the anterior end of the miracidium. The function of these cells is not known. These cells were described by Krull and Price (1932) who also could not ascribe a definite function to them.

The miracidium continues to increase in size as the result of the rapid divisions of the somatic cells. An H-shaped group of cells appears in the middle of the body (figs. 70, 72). These cells take part in the formation of the nervous, supporting and excretory structures of the miracidium. The cells with small densely staining nuclei lying just inside the epidermal plates will form the subepithelial layer. Those in the upper mid- and lateral regions of the body will form the brain mass and nerves. The rest of the cells in this group form muscles and excretory structures. While these changes are going on in the miracidium, the germinal cell has divided slightly unequally into a propagatory cell and an ectodermal cell similar to the division observed in the first cleavage of the zygote (fig. 73). The ectodermal cell divides to form the soma of the future first generation redia. After a number of divisions of the ectodermal cell, the propagatory cell divides equally to form a mass of germinal cells which remain in the posterior end of the developing redia. Krull and Price (1932) interpreted the mass of cells in the posterior part of the miracidium as a group of germinal cells. The mass is actually an embryo, the first generation redia.

When the miracidium reaches the hatching stage, the redial embryo shows signs of differentiation. It has become oval in shape and smaller cells may be seen at the future anterior end which will develop into the pharynx and gut. Other cells flatten to form the investing membrane and body wall. The germinal cells remain in a cluster at the posterior end of the redia (fig. 72, gc). They are cytologically similar to the propagatory cell in the miracidial embryo and are, in fact, direct descendants of the propagatory cell formed at the first cleavage of the ovum.

Discussion.—The development of the miracidium has been described for a few trematodes; the most detailed accounts being those of Thomas (1883) on *Fasciola hepatica*, Looss (1892) on *Diplodiscus subclavatus*, Ortmann (1908) on *Fasciola hepatica*, Johnson (1920) on *Echinostoma revolutum*, Ishii (1934) on *Fasciolopsis buski*, Watanabe (1934) on *Schistosoma japonicum*, Bennett (1936) on *Cotylophoron cotylophorum*, Chen (1937) on *Paragonimus kelli-cotti*, and Rees (1940) on *Parorchis acanthus*. Similarities exist in their early development, including the unequal size of the cells during the first cleavage.

In *Gyrodactylus elegans*, however, Katheriner (1994) found cells of equal size resulting from the first cleavage which he referred to as cells "a" and "b." The "b" cells divided equally while cell "a" divided unequally, as did its daughter cells. At the sixty-cell stage, one large cell persisted, which divided into two cells similar in appearance to the "a" and "b" cells of the first cleavage. One of these gives rise to the somatic cells and the other to embryos. That is, these two cells represent the ectodermal cell and the propagatory cell.

Ishii (1934) found an unequal division of the zygote in *Fasciolopsis buski*. He called the smaller cell the propagatory cell and the larger one with a lightly-staining nucleus and much cytoplasm the ectodermal cell. The propagatory cell remains unchanged during the first three days of incubation while the ectodermal cell undergoes several cleavages. The cells of the ectodermal line give rise to the vitelline membrane, connective tissue, nervous and excretory systems. The propagatory cell divides and one of its daughter cells produces the germ cells while the other gives rise to the gut, cephalic glands and muscles.

Watanabe (1934) found that the first cleavage produced cells of unequal size in *Schistosoma japonicum*. He further observed that the larger cell divides

several times and gives rise to the vitelline membrane and the body wall of the embryo. The cells resulting from the division of the smaller cell give rise to most of the embryo. At about the fifty-cell stage some of these cells differentiate into the germ cells while the others form the organs of the miracidium; namely, the epithelial cells, the interepithelium (cuticle-forming cells), the subepithelium, the muscles and the "Rostellumretraktoren." The cells in the inner part of the embryo give rise to the gut, glands, parenchyma, nervous tissue and the germ cells.

Chen (1937) also reported that the first cleavage resulted in the formation of a small propagatory cell and a large ectodermal cell. The latter produced the body of the miracidium while one of the daughter cells, resulting from the division of the propagatory cell, gave rise to the glands and muscles; and the other daughter cell resembled the parent cell and produced the germ cells. Rees (1939, 1940) found that a propagatory cell and an ectodermal cell resulted from the first cleavage. The divisions and subsequent differentiation of the ectodermal cells produced the body of the miracidium. The propagatory cell divides shortly after the cells which are destined to form the vitelline membrane break away from the embryo mass. One daughter cell contributes to the formation of miracidial structures while the other retains the characteristics of the parent cell. This latter cell divides into an ectodermal cell and a propagatory cell. The ectodermal cell divides repeatedly to form the body of the single redia which develops in the miracidium. The propagatory cell produces the germ cells which come to lie in the body cavity of the redia. The single redia possesses a well developed pharynx and gut by the time the miracidium hatches from the egg. In *M. temperatus*, a single redia also develops within the miracidium but it has not reached the same degree of development as that found in *Parorchis acanthus*.

Schubmann (1905) traced the development of the vitelline membrane in *Fasciola hepatica* and found it to be derived from the ectoderm of the developing embryo and not from the vitelline cells in the egg as reported by Goldschmidt (1902, 1905). Several other investigators have shown that the vitelline membrane is formed from ectodermal cells which separate early from the embryo mass and move to the inner surface of the shell (Ortmann, 1908; Ishii, 1934; Watanabe, 1934; Chen, 1937; Rees, 1940). A similar formation of the vitelline membrane was observed in *M. temperatus*.

GERMINAL DEVELOPMENT IN REDIAL GENERATIONS

Germinal cells in first generation redia.—The original propagatory cell from which the germinal cells of the first generation redia were derived can be traced back to the developing miracidium (figs. 70, 73). The germinal cells resulting from the early divisions of this propagatory cell possess large nuclei containing darkly-staining nucleoli and fine radiating strands of chromatin extending to the nuclear membrane. The outlines of the germinal cells remain distinct while those of the somatic cells are soon lost as the embryo develops. The nucleus of the germinal cell measures about 8μ and resembles that of the primary oöcyte located in the upper part of the ovary. The germinal cells form a distinct group occupying the posterior half of the developing embryo (figs. 71, 77, 78). This group does not represent a true germinal mass in the sense that the whole mass is surrounded by a membrane and remains as a persistent center of multiplication of germinal cells throughout the life of the

redia. It is nothing more than a group of cells which develop into embryos directly. At first, the germinal cells appear to be in contact with the body wall, but as the embryo grows and the body cavity forms, the clustered condition of the germinal cells becomes more apparent. The cells at the anterior end of the cluster are the first to form embryos while the cells at the posterior end divide to produce more germinal cells (fig. 77). The diploid number of chromosomes was observed in the dividing germinal cells and no condition suggesting maturation phenomena could be seen. Embryo formation takes place during the differentiation of the soma of the redia, and by the time the pharynx and gut are distinguishable, the body cavity contains a number of second generation redial embryos. In the smallest redia of *Diplodiscus subclavatus* figured by Looss (1892; fig. 5 pl. 2), the pharynx and gut are poorly developed but the body cavity is large and contains eight embryos and a number of germinal cells along the walls and at the posterior end. Germinal cells were found only at the posterior end of the redia in *M. temperatus*. Looss also showed a gradation in size of the embryo as though one germinal cell at a time divided to form an embryo. A similar gradation in size of embryos is found in *M. temperatus*.

Cleavage of germinal cells and formation of second generation rediae.—The early cleavages of the germinal cells in the first generation redia are similar to those of the fertilized ovum. The first cleavage results in the formation of an ectodermal cell and a smaller propagatory cell (fig. 91). The ectodermal cell divides slightly unequally (fig. 90). The larger of the daughter cells then divides and four types of cells can be seen; one small cell with coarsely arranged chromatin in the nucleus, one with a clear oval nucleus with a darkly staining nucleolus and a few strands of chromatin, a large cell with a large nucleus in which the chromatin forms a fine network around a dark irregularly shaped nucleolus, and the large propagatory cell with a clear nucleus containing a very large nucleolus and a few strands of chromatin radiating toward the nuclear membrane (fig. 93). The ectodermal cell continues to divide and between the eight and ten cell stage, a cell with an oval nucleus containing a darkly staining nucleolus begins to flatten along one side of the embryo. This cell divides several times and the resulting cells form a thin membrane around the developing embryo. The nuclei of the membrane cells can be traced throughout the developmental stages of the redia but with the onset of cuticle formation they suddenly disappear (figs. 97, 99, 104, 106). As the somatic cells of the embryo continue to divide, their cell outlines are lost. The cytoplasmic outline of the propagatory cell, however, is retained. Between the twelve- and fifteen-cell stage, the propagatory cell divides into two cells of equal size and similar in appearance (fig. 98). The unequal divisions of the propagatory cell in the miracidial generation have not been found to occur in the generations of embryos in the intermediate host. By the thirty-cell stage, three large germinal cells may be seen at one end of the oval embryo (fig. 101). As division proceeds, the increase in number of cells is accompanied by a shifting and migration of the soma so that the germinal cells come to lie inside the embryo mass (fig. 105). The germinal cells appear to divide more slowly than the soma cells and can, therefore, be more readily distinguished by their large size. A mass of small cells gradually appears at the anterior end of the embryo which will give rise to the pharynx and gut of the second generation redia (figs. 102, 105). The germinal cells continue to divide more

slowly than the somatic cells, and by the time the gut has developed into an elongate sac extending into the body cavity, they are arranged in a cluster in the posterior half of the body. The germinal cells at the anterior end of the cluster have already divided into small embryos of the third generation while the primordial cells in the posterior tip are producing more germinal cells (fig. 102). With an increase in production of embryos, the germinal cells are gradually used up. In older rediae, containing several well developed third generation rediae and a graded series of embryos, the number of germinal cells is considerably reduced (fig. 104). These few remaining germinal cells appear to be held in place by connective tissue fibers containing oval or spindle-shaped nuclei. These fibers surround the embryos and germinal cells in the other redial generations also.

Third generation rediae.—The third generation rediae are formed from the germinal cells in the body cavity of the second generation redia in a manner similar to that of the second generation rediae described above (figs. 85, 89, 94, 95, 97, 100, 103, 106). Although mitotic figures were few in any one redia, the stages in the division of the germinal cells were carefully traced (figs. 86, 87, 88). In the polar view of the metaphase, the diploid number of chromosomes was counted. No maturation phenomena were observed, and no cells resembling polar bodies were found.

Cercariae.—The cercariae develop from the germinal cells in the body cavity of the third generation redia. The germinal cells are arranged in a cluster in the posterior half of the developing redia. The fully grown germinal cells at the anterior end of the cluster are the first to divide to form cercarial embryos (fig. 106). The primordial cells at the posterior tip of the redia divide to form more germinal cells, while those more anterior are being used up in the formation of cercarial embryos (figs. 75, 106). Finally, as more and more cercarial embryos form and fill the enlarged body cavity, the number of germinal cells becomes reduced. When the cercaria is half grown it is forced out of the redia, thus providing more room in the body cavity for the rapidly growing embryos. Old rediae which have reached the limit of cercarial production may contain a few maturing cercariae normally found in the tissues of the host.

The early development of the cercarial embryos is so similar to that of the redial generations that the embryos cannot be distinguished (figs. 83, 84, 96, 99). Later, however, the cercarial embryos can be recognized by the greater number of cells than that found in redial embryos of comparable size. The multiplication of the soma is so rapid that there is little time for growth of the cells. This is evidenced by the small size of the cells at the time of tissue differentiation. The propagatory cell has also undergone repeated divisions, and the germinal cells have become considerably reduced in size by the time the cercaria is half grown. These cells are arranged in a single primordium located in the middle of the cercarial body. At the anterior end, the cells have grouped to form the oral sucker and pharynx (fig. 109 a, b). As the embryo elongates, the genital primordium differentiates into three groups of cells (fig. 107). The anterior mass, located near the bifurcation of the intestine, will form the cirrus pouch and part of the uterus. The other two masses will give rise to the testes and ovary and their accessory structures.

While the reproductive organs are developing, other cercarial structures are also being differentiated. The oral sucker with its pharyngeal pockets, mus-

cular pharynx, and intestinal ceca take on their characteristic form. The posterior sucker has become a large terminal disc; the tail is elongating and the excretory bladder becomes a thin-walled cuticularized sac which opens on the dorsal surface of the body near the sucker. The brain is a well developed bilobed structure and the eyespots become pigmented. The cystogenous glands are large lateral cells in which rod-like bodies appear as the cercaria matures.

In the mature cercaria, a thin membrane has formed around each testis and the cells contained therein begin to undergo maturation (fig. 110). The cells composing the ovary have become differentiated from the cells of the oviduct and Mehlis' gland, but as yet, have not entered into the maturation process (fig. 110). The testes may contain mature spermatozoa in the cercaria, but the oögonia increase in number only after the cercaria arrives in the definitive host.

DISCUSSION

The origin and development of the germinal cells which give rise to the sporocyst and redial generations have been discussed by a number of investigators. Moulinié (1856) and Pagenstecher (1857) described "endogenous cell formation" as being the mode of origin of the germ cells in the sporocyst and redia. Wagener (1866), Biehringer (1884), Looss (1892), Reuss (1903), Haswell (1904), Tennent (1906), and Roszbach (1906) also considered the germ cells to arise from cells in the body wall of the sporocyst or redia. Reuss and Tennent described maturation stages and polar body formation in these cells.

Leuckart (1882) concluded that the germ cells in the sporocyst and redial generations could be traced directly to the fertilized ovum. Although the germ cells had not yet differentiated from the soma in the posterior end of the sporocyst in *Fasciola hepatica*, Leuckart (1879) believed that they had been carried over in the body activity and retained their embryonic character. Thomas (1883) stated that the rediae developed from germ cells already present in the body cavity and from additional germ cells in the body wall in *F. hepatica*.

Looss (1892) reported that the germ cells arose from the body wall of the sporocyst in *Diplodiscus subclavatus* and, when the sporocyst became older, production was limited to its posterior end. Biehringer (1884) stated that the germ cells budded off from the wall at the posterior end of the sporocyst. Reuss (1903) considered the germ cells to originate from undifferentiated cells from all places on the body wall of the sporocyst of *Distomum duplicatum*. He also concluded that maturation of the germ cells took place in the wall. However, his only evidence was the fact that he found small darkly staining nuclei attached to the larger so-called germ cells which he interpreted as polar bodies. Haswell (1903) described similar cells with deeply staining nuclei as lying in the body cavity near the "ovary" at the posterior end of the sporocyst of *Echinostomum* sp.

Tennent (1906) described two methods for germ cell production in the sporocyst of *Bucephalus haimeanus*. The one method is a scattered production of germ cells from the wall of the sporocyst. The other is through a more localized production in which a certain portion of the wall of the sporocyst, usually at the end of one of the branches, grows a blunt process into the body cavity which functions as the center of germ cell production. The germ cells undergo two maturation divisions with the formation of three polar bodies

while still in the wall or after they have been freed from the center of production. Dollfus (in private communication to Brooks, 1930) said that he failed to find maturation stages or polar bodies in this same species. He stated further that he had never seen polar bodies in any of the sporocysts and rediae he had studied.

Brooks (1930) considered the germ cells to come from the primordial germ cell set aside after the segmentation of the fertilized ovum. He found that the rediae and cercariae were formed by a dissociation of the germ masses which developed from antecedent germ cells in the body cavity of the sporocyst or redia.

Cable (1934) concluded from his studies on *Cryptocotyle lingua* that the germ cells are distinct from the soma in the rediae and appear as primordial germ cells at the posterior end of the redia. However, he was unable to trace the germ cells back into the small germ balls. Chen (1937) traced the germ cells in the sporocyst back to the germ cells in the miracidium in *Paragonimus kellicotti*. She was also able to trace the germ cells through the germ ball stage into the fully grown rediae and cercariae. She found no maturation stages or polar body formation in any of these stages. Rees (1940) found in *Parorchis acanthus* that the germ cells are distinct from the soma in the redial and cercarial generations and that they do not originate from the body wall. She considered them to be direct descendants of the propagatory cell resulting from the first cleavage of the fertilized ovum.

Cable (1934), Chen (1937) and Rees (1940) failed to find germinal masses in any of the rediae and sporocysts which they studied. The failure of these workers to find germinal masses, as described by Brooks, led Cort (1944) to make the following statement: "It can possibly be suggested, therefore, that in groups with rediae as secondary sacs in which rather limited numbers of cercariae are produced, the multiplication of the individuals may be entirely by direct division of the cells of the germinal line."

Brooks (1930), Cable (1934), Chen (1937), and Rees (1940) all found the theory of germinal lineage with polyembryony applicable to the trematodes they studied. The more recent studies of Cort and his co-workers on living immature rediae and sporocysts fit in with the germinal lineage theory.

SUMMARY

The germ cell cycle of *Megalodiscus temperatus* was traced through all developmental stages; the adult, miracidium-sporocyst, rediae and cercaria. Oögenesis, spermatogenesis, maturation of the germ cells, and fertilization of the oöcyte were studied in the adult.

The diploid number of chromosomes was found to be eighteen.

Cleavage of the fertilized ovum results in two cells of unequal size. The larger or ectodermal cells gives rise to the soma of the miracidium, while the smaller propagatory or stem cell contributes to the soma and retains the germ plasma in a certain large cell, the germinal cell. When the miracidium is half grown, the germinal cell, located in the posterior part of the body, divides into an ectodermal cell and a propagatory cell. The ectodermal cell divides repeatedly and gives rise to the body of the first generation redia which contains in its posterior part the descendants of the propagatory or stem cell.

During the penetration of the miracidium into the snail host, *Helisoma trivolvis*, the epidermal plates are retained; but they have disappeared by the

time the miracidium has reached the stomach wall of the snail where it develops into the sporocyst.

The single first generation redia breaks out of the sporocyst between the 17th and 19th days of infection, and remains in the lymph space near the stomach wall.

The second generation rediae, formed as a result of the divisions of the germinal cells in the body cavity of the first generation redia, escape from their parent about 24 to 26 days after infection and migrate to the apical whorl of the snail where they feed on liver tissues. The germinal cells in their body cavities give rise to the third generation rediae.

The third generation rediae migrate toward the proximal portion of the liver. The germinal cells in this generation, and possibly later generations of rediae, give rise to cercariae by a process of embryonic development similar to that found in the preceding generations.

The propagatory cell in the cercarial embryo divides repeatedly, and the germinal cells, considerably reduced in size, are arranged in a single genital primordium. During growth and tissue differentiation of the cercaria, this primordium separates into three groups of cells; the anterior group gives rise to the cirrus pouch and part of the uterus, the posterior group develops into the female reproductive structures, and the middle group of cells gives rise to the testes and accessory male structures. In the mature cercaria, spermatozoa are already present in the testes, while in the ovary, the oögonia have just begun to multiply.

The development of all three generations of rediae was followed from a single cell to fully developed individuals. No condition suggesting maturation phenomena or polar body formation was observed.

No indication was found that the germinal cells are derived from the body wall. They are distinguishable from the somatic cells in the early embryos.

In the redial generations, no structures were found which could be interpreted as ovaries or testes, or even as persistent germinal masses. The germinal cells in the miracidial and redial generations develop directly into embryos, while the germinal cells differentiated in the cercarial stage undergo maturation and continue to do so throughout the life of the adult.

CONCLUSION

The theory of germinal lineage with polyembryony can be applied to *Megadoliscus temperatus*. The germ cells are localized in the ovaries and testes of the adults where they undergo maturation and fertilization in a manner similar to that in other metazoan animals. At the first cleavage of the fertilized ovum, the germ plasm is segregated into one of the daughter cells, the propagatory cell. This cell gives rise to a germinal cell at the time of differentiation of the miracidium which will develop into the first generation redia. At the first cleavage of this germinal cell, the germ plasm is once again segregated into a propagatory cell which divides into germinal cells with equally distributed germ plasm. These germinal cells multiply, grow, and develop into embryos of the second generation redia. The segregation of the germ plasm continues in this manner through three, or possibly more, generations of rediae, and finally stops with the formation of cercariae. Each generation of germinal cells may be found in the posterior part of the redia, but are not localized into definite germinal masses or "ovaries," and do not undergo maturation.

In the cercaria, the segregated germinal cells multiply to form the genital primordium. Some of the cells of the primordium give rise to the accessory reproductive structures while others form the ovaries and testes. After the genital organs have become established in their proper positions, the germ cells differentiate into oögonia and spermatogonia.

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EXPLANATION OF PLATES

ABBREVIATIONS: bl—excretory bladder, br—brain, cg—cystogenous glands, ep—epidermal plate, gc—germinal cell, gl—penetration gland, gp—genital primordium, i—intestine, m—Mehlis' gland, o—ovary, os—oral sucker, p—propagatory cell, p_1 —descendants of the propagatory cell, pg—primitive gut, ph—pharynx, sp—sporocyst wall, t—testis, ut—uterus, vm—vitelline or investing membrane.

PLATE I

Figs. 1-28.—1. Primary spermatogonia along the testicular membrane. 2. Primary spermatocyte showing leptotene threads, one cell from a cluster of eight. 3. Primary spermatocyte, diplotene stage, one from a cluster of eight. 4. Primary spermatogonium in late prophase. 5. Primary spermatogonium in metaphase, polar view showing the diploid number of chromosomes. 6. Two secondary spermatogonia in late prophase. 7. Primary spermatogonium in early prophase. 8. Primary spermatogonium in late anaphase. 9. Four tertiary spermatogonia in late prophase. 10. Two secondary spermatogonia in interphase. 11. Primary spermatogonium from the testis of the cercaria. 12. Eight primary spermatocytes in early prophase. 13. Four tertiary spermatogonia. 14. Primary spermatocytes showing tetrads; a, b, c are three consecutive sections. 15. Developmental stages of the spermatozoon taken from a smear preparation. 16. Secondary spermatocyte cluster showing dyads, taken from a smear preparation. 17. Primary spermatocyte cluster showing tetrads, taken from a smear preparation. 18. Uncoiling of the spermatozoon. 19. Secondary spermatocytes in metaphase; a, b, c are three consecutive sections. 20. Primary spermatocyte cluster in late anaphase, taken from a smear preparation. 21. Section of spermatid cluster. 22, 23. Elongation of the spermatids. 24. Immature spermatozoa, taken from a smear preparation. 25. Secondary spermatocyte cluster in anaphase and telophase stages. 26. Coiled immature spermatozoa in cytoplasmic mass. 27. Transformation of spermatids. Only five spermatids of the cluster shown. 28. Mature spermatozoa taken from a smear preparation.

PLATE II

Figs. 29-60.—29. Oögonium in interphase. 30. Oögonium in prophase. 31. Primary oöcyte in pachytene stage. 32. Growing primary oöcyte showing fine diplotene threads. 33. Oögonium in late prophase. 34. Primary oöcyte showing leptotene threads. 35. Bouquet stage in primary oöcyte. 36. Primary oöcyte in pachytene-synaptene stage. 37. Full grown primary oöcyte taken from the anterior end of the ovary. 38, 39. Abnormal cells from the testis. 40. Oögonium in metaphase. 41. Oögonium in telophase. 42. Primary oöcyte in diplotene stage. 43. Growing primary oöcyte showing the loss of diplotene threads. 44. Primary oögonium taken from the ovary of the cercaria. 45, 46. Abnormal cells from the testis. 47. Oöcyte in the oviduct just after penetration of the spermatozoon. 48. Cell resembling an oöcyte, from the testis. 49. a, b. Primary oöcyte in two sections. Consolidation of the spermatozoon (a), oöcyte in late prophase (b). 50. Oöcyte in early anaphase. 51. a, b. Two sections of a primary oöcyte showing the tetrads and the consolidation of the spermatozoon. 52. Primary oöcyte showing the tetrads in polar view. 53. a, b. Two sections of the oöcyte showing the formation of the first polar body. 54. Zygote in metaphase prior to the first cleavage; second polar body still adhering to the cell membrane. 55. a, b, c. Primary oöcyte showing the first polar body and a vitelline cell (a), formation of the second polar body (b), clumped chromosomes of the spermatozoon (c). 56. Zygote with an irregularly shaped fusion nucleus in early prophase. 57. Zygote in anaphase prior to the first cleavage. 58. Egg containing the zygote with its pronuclei, vitelline cells and polar bodies. 59. a, b. Two-cell stage with the propagatory cell in two sections (a, b); the ectodermal cell in polar view, showing eighteen chromosomes (b). 60. Zygote in late prophase with the first and second polar bodies along the cell membrane.

PLATE III

Figs. 61-69.—61. a, b. Sections of a two-cell embryo; the ectodermal cell is in prophase. 62. Three-cell embryo; two ectodermal cells and one large propagatory cell. 63. Six-cell embryo showing undivided p cell. 64. a, b. Section of an 11-cell embryo showing the propagatory cell (p) and the vitelline membrane cell (vm) beginning to separate from the embryo in 64a. Reconstruction of embryo to show position of p cell and p_1 cell (mesoderm line?) in 64b. 65. Section of 15-cell embryo showing division of p and p_1 cells. 66. a, b. Section of a 21-cell embryo showing large p cell and two p_1 cells in a, and reconstruction of the embryo in b. 67. a, b, c. Three sections of an embryo of

about 40 cells showing vitelline membrane and darkly staining bodies in 67a, the unequal division of the p cell in b, and one of the primitive gut or apical gland nuclei (pg) in c. 68. a, b. Two sections of an embryo of about 60 cells showing a pg nucleus in a, and the unequal division of the p cell in b. 69. a, b. Sections of an embryo of 90-100 cells showing two pg nuclei, vitelline membrane nuclei, and darkly staining bodies in a, the p cell, some of the p₁ cells, and the dark bodies also outside the embryo in b.

PLATE IV

Figs. 70-79.—70. Half grown miracidium with one large germinal cell in the posterior part of the body (gc). 71. Two-day-old sporocyst containing a first generation redia (Drawn from living specimen). 72. Older miracidium containing the first generation redial embryo, showing the germinal cells (gc), the penetration gland nuclei (gl), and the nuclei of the primitive gut (pg). 73. Section through the posterior half of a miracidial embryo showing the large ectodermal cell and the smaller propagatory cell. 74. Sporocysts from an 11-day infection containing the first generation redia (Drawn from living specimen). 75. Recently emerged third generation redia showing the extent of germinal development (Drawn from living specimen). 76. Section through the posterior part of a 14-day-old sporocyst and first generation redia. All that remains of sporocyst is thin membrane (sp). 77. Sporocyst from a seven-day infection, containing the first generation redia with germinal cells and young embryos in the body cavity. Pharynx and gut barely distinguishable (Drawn from living specimen). 78. Section through miracidium-sporocyst 12 hours after penetration into snail, showing the swollen epidermal plates (ep) and a few remaining cilia. 79. First generation redia teased from a 14-day-old sporocyst (Drawn from living specimen).

PLATE V

Figs. 80-106.—80-83. Comparison of germinal cells which will form first generation redia, second generation redia, third generation redia, and cercaria, respectively. 84, 85. Comparison of first cleavage of cercaria with that of third generation redia. Compare with figs. 91 and 73. 86-88. Mitotic stages of germinal cells which will form third generation rediae. This type of division is typical of germinal cells in all generations of rediae and cercaria. 89. Two-cell stage of a third generation redia with ectodermal cell in division. 90. Three-cell stage of second generation redia. 91. Two-cell stage of second generation redia. 92. Section of an 8-cell stage of a second generation redia, p cell unchanged. 93. Four-cell stage of second generation redia. 94. Section of an 8-cell stage of third generation redia. Compare with fig. 92. 95. Section of 12-cell stage of third generation redia. 96. Three-cell stage of a cercarial embryo. 97. Later stage of a third generation redia. Note the p cell and the vitelline or investing membrane nucleus. 98. Section of 15-cell stage of second generation redia with two germinal cells. 99. Section of 12-cell cercarial embryo. Compare with fig. 95. 100. Three-cell stage of third generation redia. 101. Section of 30-cell stage of second generation redia containing three germinal cells, one in prophase. 102. Section through an older second generation redia showing the developing pharynx (ph) and intestine (i), and the extent of germinal production. 103. Section of a third generation redia with three germinal cells at one end. 104. Section of the posterior half of a second generation redia which has a well developed pharynx, intestine, and brain mass. Note increase in number of embryos and reduction in germinal cells as compared with fig. 102. 105. Section of second generation redia containing five germinal cells and a cluster of cells which will develop into the pharynx and intestine (ph). 106. Section of an older third generation redia showing the extent of germinal production. The group of cells in the anterior part of the body cavity represents the developing intestine.

PLATE VI

Figs. 107-110.—107. Half grown cercaria from a third generation redia showing the genital primordium differentiated into three groups of germinal cells (gp). 108. First generation redia from a 21-day infection (Drawn from living specimen). 109. a, b. Two sections of a cercarial embryo from a third generation redia showing a single genital primordium (gp). The group of cells in 109a will give rise to the oral sucker and intestine (os); the group of cells at the posterior end in 109b will give rise to the posterior sucker and tail (ps). 110. Section of mature cercaria from the tissue of the snail showing one of the testes (t), the primordium of the uterus (ut), Mehli's gland and oötype (m), the ovary (o), and the cystogenous glands (cg).

PLATE I

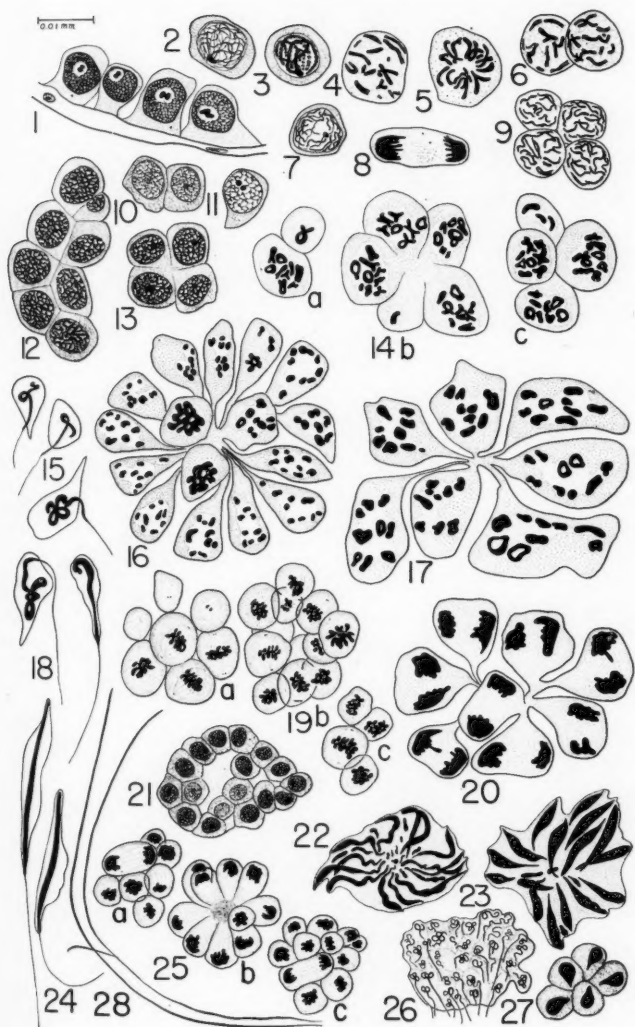


PLATE II

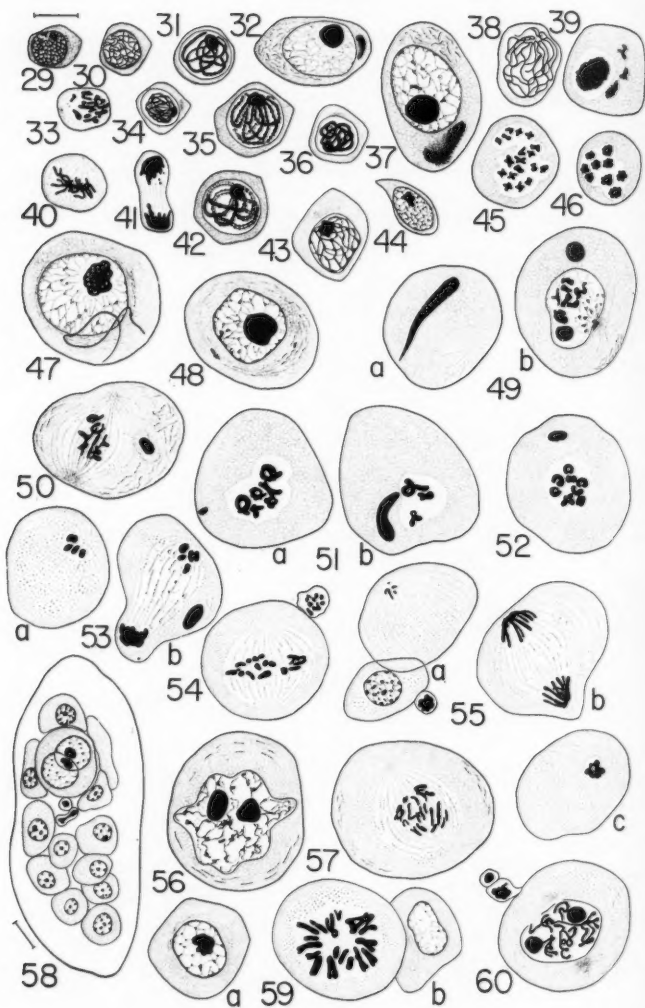


PLATE III

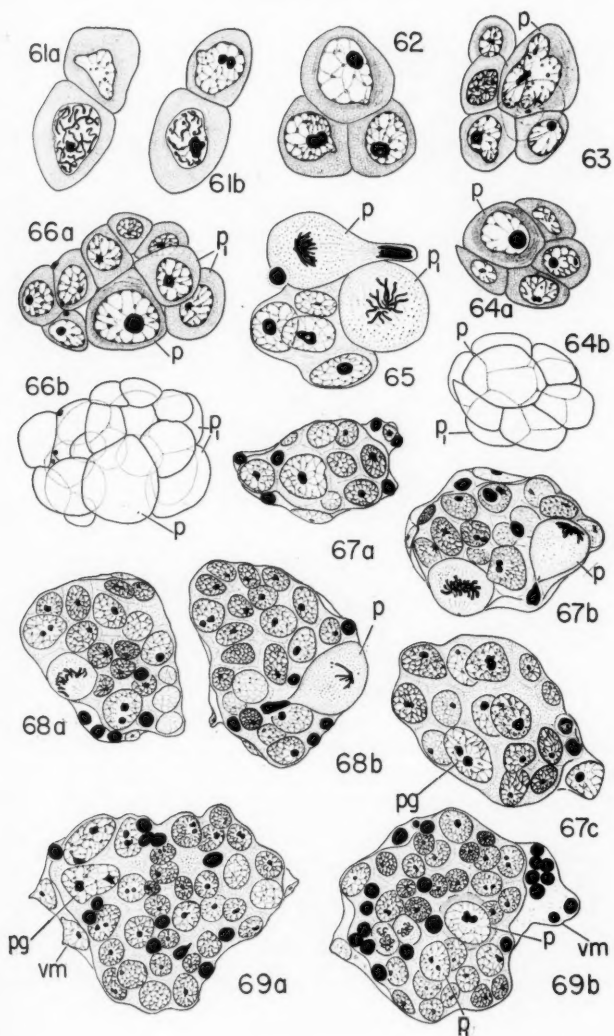


PLATE IV

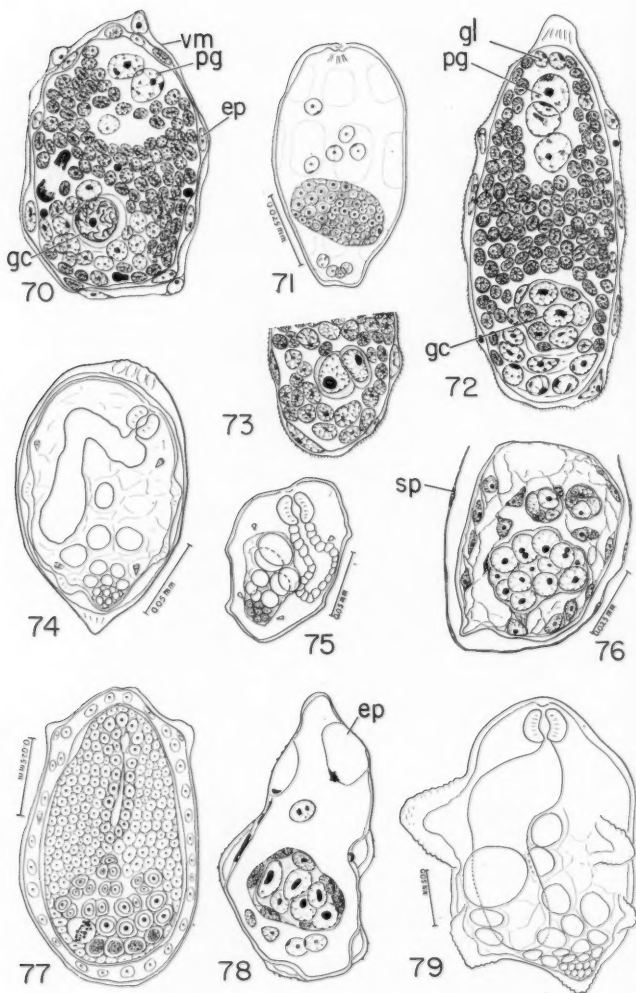


PLATE V

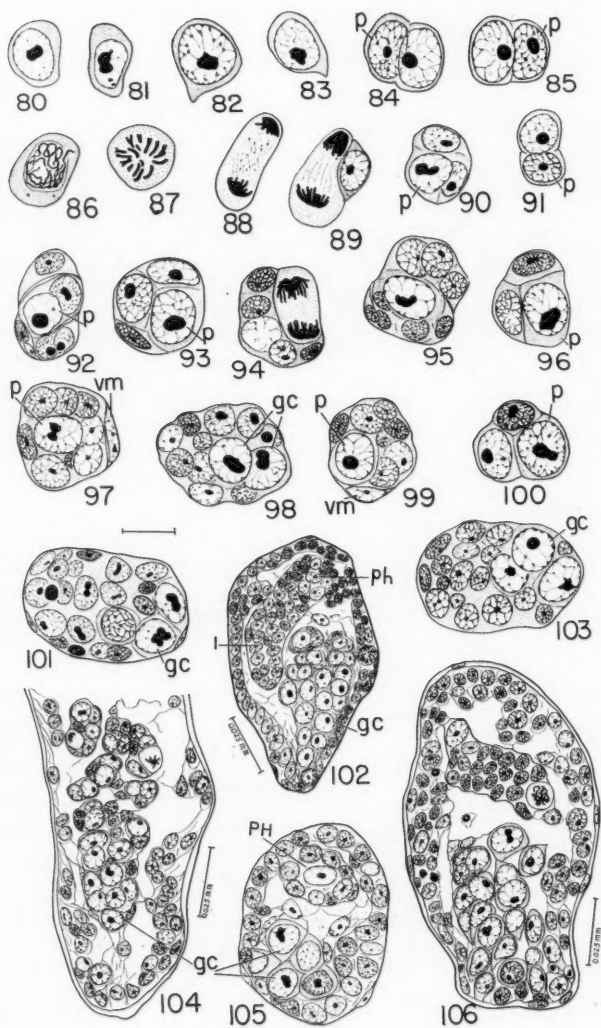
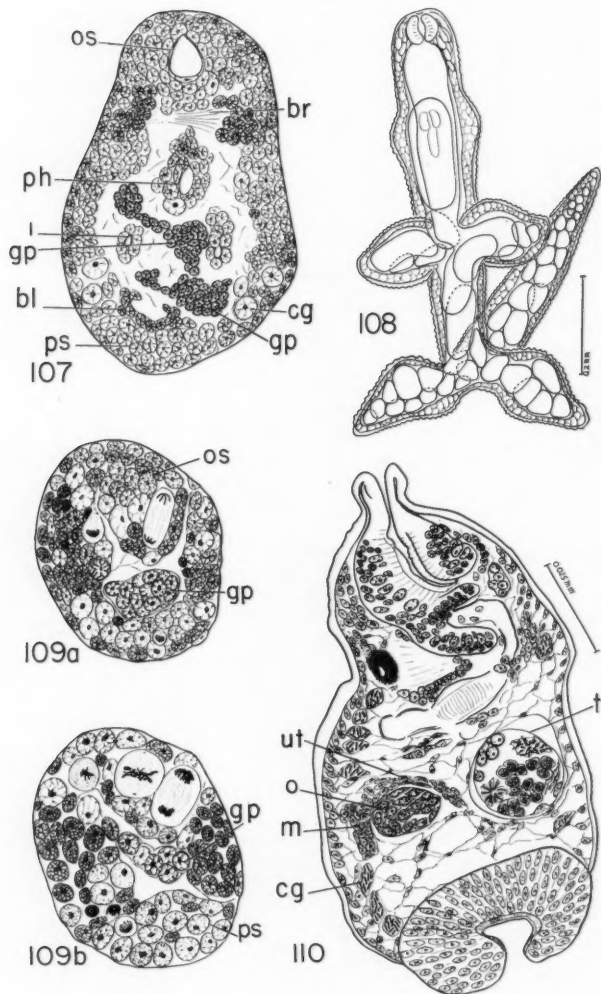


PLATE VI



Some Plant Communities in the Anthracite Region of Northeastern Pennsylvania*

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In northeastern Pennsylvania, the Hemlock-White Pine-Northern Hardwoods Region which has been studied intensively by several ecologists (Lutz, 1930; Hough, 1936, 1937, 1943; Hough and Forbes, 1943; Morey, 1936) contacts the Ridge and Valley Section of the Oak-Chestnut Region (Braun, 1950). It has been recognized that a transition zone exists between these two forest regions (Illick and Frontz, 1928). In general, the various authors (Illick and Frontz, 1928; Nichols, 1935; Braun, 1950) agree in limiting the Hemlock-White Pine-Northern Hardwoods Region, as it occurs in Pennsylvania, to the Allegheny Plateau. To the southeast, this plateau borders the Ridge and Valley Section of the Appalachians in which the Oak-Chestnut is the predominant forest. The purpose of the present study is to analyze and describe in terms of qualitative and quantitative phytosociological concepts some of the forest communities in this transitional region, to relate the communities to their topographic and edaphic factors, and to discuss the interrelationships of the various communities as they occur on the Pocono Plateau in Bear Creek Township, Luzerne County, Pennsylvania (fig. 1).

This county has a forest situation that is typical of the Anthracite Coal Region of northeastern Pennsylvania. The forests have borne the burden of lumbering since 1800 when there were already 13 sawmills in the county, concentrating on the white pine and hemlock (Clark, 1875). But it was mainly during the last part of the nineteenth century, when lumbering reached its climax in Pennsylvania (Pa. Dept. of Commerce, 1946), that the greatest amount of clear-cutting of lumber took place in Luzerne County. Further, there has been an extreme drain on the forest resources of this county by the constant demand of the coal mining industry for gangway timbers, mine props and lagging (Ineson and Ferree, 1948). All timber down to poles 3 inches in diameter finds utilization in the mines. Hence, clear-cutting was often practiced, and complete destruction of the refuse together with any sprout growth was often brought about by fire. A phytosociological record of the forest communities of this region in their present condition will be valuable for comparison with that of future forests which will result from the more scientific, selective cuttings which are now recommended.

LITERATURE

The Hemlock-White Pine-Northern Hardwoods Region in Pennsylvania was studied and delimited by Illick and Frontz (1928). Due to the scarcity of hemlock and white pine in the second-growth stands which were the object

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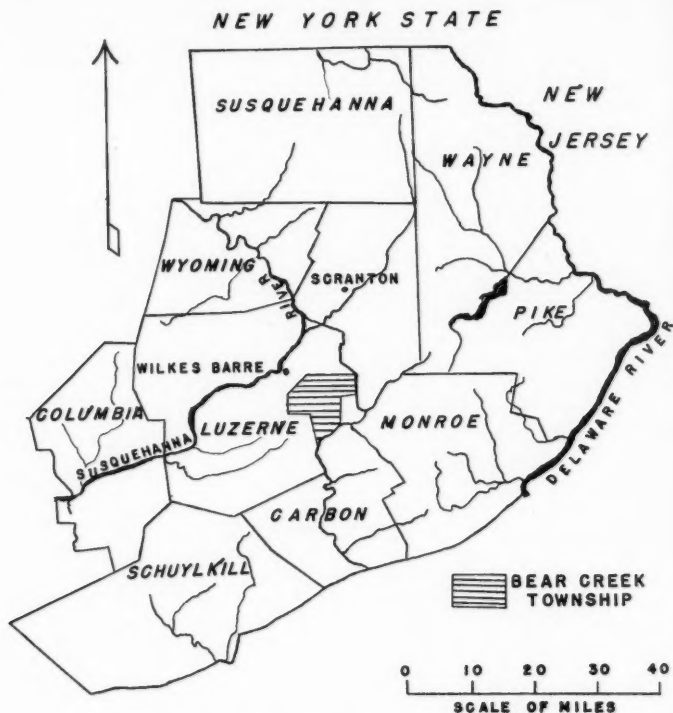


Fig. 1.—Map of northeastern Pennsylvania showing counties, and the location of the study area in Bear Creek Township

of their study, they referred to the forest as the beech-birch-maple type. These authors presented a map delimiting this forest type, but stated that owing to range in elevation, variation in soils and other growth factors, as well as to the intermingling of the oak-chestnut forest with the beech-birch-maple in transition zones, it was difficult to fix definite geographic boundaries. They found that while the most southerly, typical and extensive forests of the beech-birch-maple type occur in the highlands of northern Pennsylvania, this type extends southward along the Appalachian Mountains. But in this more southerly extension, the type occurs in more or less detached bodies at higher elevations, along streams, and in cool valleys. They considered *Quercus alba* to be the most important indicator tree of the oak-chestnut forest in northern Pennsylvania.

The few remaining virgin stands of hemlock-white pine-northern hardwoods in northern Pennsylvania have been investigated by various authors (Lutz, 1930; Hough, 1936, 1943; and Hough and Forbes, 1943). In Heart's Content, a virgin forest in northwestern Pennsylvania, Lutz recognized two

forest communities: a hemlock-beech association and a hemlock consociation. He concluded that the hemlock-beech association is less advanced than the climatic climax of the region, which he concluded would contain considerably less white pine. The hemlock consociation was regarded as a physiographic climax which was probably of common occurrence on the moister soils in the primeval forests. These conclusions were substantially verified by the work of Hough and Forbes (1943) on the age relationships among the trees in virgin stands.

A general description of the vegetation of the Ridge and Valley Section of the Oak-Chestnut Region as it occurs in Pennsylvania was given by Braun (1950). She emphasized the fact of local variation in forest communities due to the great variation in the physiography of the region. While oaks are now the principal dominants, chestnut shared this dominance until it was killed by the blight. Braun stated that the dominance of white oak in the forests of the valley floors is a unifying character throughout the entire north and south extent of the Ridge and Valley section.

Niering (1953) found that in northwestern New Jersey a chestnut oak community forms the continuous phase of the vegetation. He also described a white oak-hickory community along the valley floors and mixed oak-hardwoods in broad, sloping valleys. Pine-scrub oak is present on ridge tops; pine-oak, on minor hill tops; and northern hardwoods both with and without hemlock, in highly restricted habitats in ravines. There are also swamp and bog forests composed of hemlock, black spruce and southern white cedar interspersed with red maple, yellow birch and black gum.

Spaulding and Fernow (1889) reported that white pine was well developed along the water courses, and that in Luzerne County, this was true of Bear Creek and its tributaries.

DESCRIPTION OF THE REGION

Physiography.—In northeastern Pennsylvania, Wyoming Valley, a huge syncline some 62 miles long and 5 miles wide at the broadest part, runs in a northeasterly direction (Darton, 1940). This valley, which is a northern projection of the Ridge and Valley Section of the Appalachian Mountains, bisects the plateau region of northern Pennsylvania. West of the valley is the Allegheny Plateau; and to the east is the Pocono Plateau. The study area, located immediately to the southeast of the valley, is close to the western border of the Pocono Plateau. This plateau, an upland of approximately 2000 feet elevation, has a rolling topography. It is probably an imperfect peneplain, eroded and glaciated after uplift (Fenneman, 1938). During the Pleistocene, northeastern Pennsylvania was covered in succession by the Jerseyan, Illinoian and Wisconsin ice sheets. This last reached its southern limit some 15 to 20 miles southwest of Wilkes-Barre (Itter, 1938). Glaciation has dotted the Pocono Plateau with lakes and swamps. The study area is covered largely by the map: Wilkes-Barre East Quadrangle, 7.5 minute series, U. S. Geological Survey, 1950.

Geology.—A cross-section of Wyoming Valley reveals five major geological formations: surface deposits of glacial till, the anthracite coal measures, Pottsville conglomerate, Mauch Chunk red shale and Pocono sandstone. However, in most places on the Pocono Plateau, geological erosion has removed the various formations down to the very resistant Pocono sandstone. In the

study area, this sandstone forms the base rock and the parent material for most of the soils. Remnants of Pottsville conglomerate and Mauch Chunk red shale as well as deposits of glacial till are also present in restricted localities.

Climate.—The nearest point to the study area for which complete climatological data are available is Scranton, 18 miles to the northeast at an elevation of 750 feet. Certain records are available for Wilkes-Barre, 8 miles to the northwest at an elevation of 610 feet. Both of these stations give only an approximation of the climatological conditions in the study area which is at an elevation of about 2000 feet. A twelve-year record for Wilkes-Barre shows that the average date for the last killing frost is April 27; the average date for the first killing frost is October 7; and the average growing season is 163 days (U.S.D.A., 1941). A sixty-six-year record (U.S. Dept. of Commerce, 1951) of precipitation in Wilkes-Barre shows an annual average of 38.89 inches which is distributed rather evenly throughout the months from January to December as follows: 2.54, 2.67, 3.10, 2.83, 3.52, 4.06, 4.38, 3.86, 3.41, 3.14, 2.62, and 2.76 inches. The monthly and annual average precipitation in Scranton is very similar. A fifty-one-year record of temperature in Scranton shows an annual average of 49.4 degrees F. with monthly averages for January through December as follows: 26.6, 27.3, 35.7, 48.1, 59.4, 67.8, 71.7, 70.2, 62.9, 51.9, 40.5 and 30.7 degrees. It is certain that conditions at the higher elevations of the study area are somewhat more severe than those recorded for the valley.

METHODS

Field investigations were made in September, 1951, and from June through September, 1952. Reconnaissance, aided by the use of aerial photographs, revealed the presence of several distinct communities. Representative stands of these communities were selected for quantitative study. In the forest communities, a standardized sampling technique (Oosting and Reed, 1944; Cottam, 1949; Quarterman, 1950; and Roach, 1952) was employed in which ten sets of nested quadrats for the various strata were distributed evenly along two separate lines through the longest axis of the stand. The arborescent stratum was sampled by 10 by 10 meter quadrats in which the tree species 1 inch or more in diameter at breast height (d.b.h.) were listed by species, counted and measured for diameter at breast height. The sample area for the trees in each stand was, therefore, 1000 square meters. The shrubs and tree transgressives were sampled in ten quadrats which were 4 by 4 meters, and placed in one corner of the 10 by 10 meter quadrats. In these quadrats, all of the tree transgressives under 1 inch d.b.h. and shrubs were listed by species, and counted in two size classes: under 1 foot high, and over 1 foot high. The herbaceous layer was sampled by ten 1 by 1 meter quadrats placed in one corner of the 4 by 4 meter quadrats. The shrub layer was, therefore, sampled in an area of 160 square meters; and the herbaceous layer, in an area of 10 square meters in each stand.

Tree species were divided into five size classes: transgressives under 1 foot tall and over 1 foot tall, trees 1-3.9 inches, 4-9.9 inches, and 10 or more inches d.b.h. From the data obtained on the tree stratum, computations were made of the density, percentage of total density, percentage frequency, basal area, percentage of total basal area, number of size classes represented, and the modified DFD index (importance value) of Curtis and McIntosh (1951). This

last is useful in giving a very generalized picture of the relative importance of the dominant tree species. For a given species within a stand, the importance value is the sum of its percentages of total density, total basal area and total frequency of all the species in the stand. This summation index has a constant value of 300 for all of the species in a stand taken together.

It was found that the shrubby communities could not be sampled satisfactorily by the quadrat method because of the density of the vegetation. In these communities, the sampling was done by means of a line intercept method (Bauer, 1936, 1943; Stern and Buell, 1951 and Bard, 1952). A series of ten 10-meter transects was located in each stand on alternate sides of two separate lines running through the longest axis of the stand. In the sampling of these stands, a division was made between those species which contributed to the overstory and those which formed the understory. The species which formed the overstory were listed for each transect on which they occurred, counted, and the amount of space they occupied along the transect was measured. Thus the percentage of cover that each species contributed to this stratum could easily be computed. The species in the understory were merely listed and counted. Density and frequency could therefore be computed for all species.

Increment borings were made of a representative group of trees in each forest stand in order to establish the age of the stand and also the age relationships among certain species.

A soil profile was dug in a representative portion of each stand. This profile was analyzed for such characteristics as depth of horizons, color (Munsell, 1936), pH (Lamotte calorimetric method), root penetration, drainage and rockiness. Soil texture was determined by a hydrometer method (Buoyoucos, 1951).

The nomenclature followed in this paper is that of Fernald (1950) except in those few cases where the author is indicated.

LOCATION OF STANDS

The white oak-red maple stand A, the scrub oak stand and the hemlock-black spruce stand were located at various elevations on Wyoming Mountain in the vicinity of Laurel Run Road. The scrub oak stand covered the entire crest of the mountain, and extended down the slopes in several different directions. The elevation was 2100 feet, the highest in the vicinity. The slope varied from 10 to 15 degrees on the mountain sides to a comparatively flat area on the very crest. The white oak-red maple stand A was at an elevation of about 1900 feet on a southeastern slope of 10 to 15 degrees. To the south-east of this stand, the hemlock-black spruce stand was located in a flat, poorly drained area at the base of the mountain.

The white oak-red maple stand B was located about three quarters of a mile west of Bear Creek Lake, just south of Route 115. It was at an elevation of 1700 feet on a south slope of only a few degrees. The white oak-red maple stand C was at approximately the same elevation, but on a north slope of a few degrees. It was just southwest of Saint Elizabeth's Church off Route 115.

The blueberry-black spruce-larch community was located in a bog about one half mile from the northeastern end of Crystal Lake; and at an elevation of 1900 feet.

The hemlock-beech-white pine stand was located east of Bear Creek Lake at an elevation of 1500 feet. It was on a very moderate, north slope of about

5 degrees. The hemlock-beech stand was located on the western shore of Bear Creek Lake on an extremely steep slope varying from 30 to as much as 50 or more degrees. This steep hillside, facing the northeast, rose in a short distance from 1560 to over 1800 feet.

The maple-black cherry, the red maple-beech and the red oak-red maple stands were located about a quarter of a mile northeast of Bear Creek Lake at varying elevations on the sides of the Bear Creek Ravine. The maple-black cherry stand was on an almost level tract about twenty feet above the creek. The red maple-beech stand was located immediately east of, and at a slightly higher elevation than the previous stand. Its elevation was 1600 feet and its slope, about 10 degrees. The red oak-red maple stand was located on the crest of the hill east of the stands just described, and at an elevation of approximately 1800 feet. Its topography was comparatively flat with a slight dip to the east and west borders of the stand.

RESULTS

GENERAL DESCRIPTION OF THE VEGETATION

A general description of the vegetation of the study area is preliminary to the detailed analysis of certain communities. A relationship between the forest communities and the topography is discernible. In general, the white oak-red maple community, thriving on the more mesic slopes and on the well drained valley floors, forms a matrix about all the other communities. Frequently there is a vertical zonation between low, poorly drained areas and the mountain tops. In swampy areas, occurs a hemlock-spruce bog forest or some stage of succession in that direction as the blueberry-spruce-larch bog. When these bog communities are at the base of a more or less steep hill, there is generally a very sharp ecotone between them and the white oak community that occurs at slightly higher elevations where the soil is better drained. If the topography between the swampy depression and the mountain side is more gradual, there is usually a more extensive ecotone between the two communities. In such an ecotone, *Betula populifolia*, *Acer rubrum*, *Viburnum nudum*, *Vaccinium angustifolium*, *Kalmia angustifolia* and *Cornus canadensis* are common.

If the topography is moderate and well drained, the white oak-red maple forest extends over considerable areas. However, if the topography is rather steep, there is a general tendency for the white oak to be more common towards the bottom of the slopes, and for red oak to become more important at the slightly higher elevation. However, these two species are usually associated in any white oak forest, so that the quantitative variation according to elevation is a matter of degree rather than a change in community type. On the broad, flat ridge-tops, the scrub oak community is extensive. In certain parts of this community, the soil is shallow with rock outcrops appearing from place to place. Hence, in a general way at least, a progression can be traced from the more hydric to the more xeric communities: hemlock-spruce dominance, white oak dominance, white oak-red oak dominance, scrub oak dominance.

In the extensive Bear Creek Ravine are remnants of primary stands of hemlock-beech and hemlock-beech-white pine that are probably typical of the forests that once covered the ravines. After the lumbering of this original type, a diversity of second growth forests followed. A topographical zonation of these second growth forests can be noted. In general, a hemlock-beech-

yellow birch community with a dense growth of *Rhododendron maximum* developed at the lowest elevations along the banks of the streams. Above this, the maple-black cherry community occurred, and at a still higher elevation, the red maple-beech community. On the extremely steep, rocky sides of the ravine, *Populus grandidentata*, *Betula lenta*, and *B. lutea* are common. Just below the crest of the hill, where the soil is shallow and the drainage rapid, there is an open growth of *B. populifolia*, *P. grandidentata* and *Acer rubrum*. *Dennstaedtia punctilobula* grows luxuriantly here as at all other elevations on the hillside. On the very crest of the hill, there is a very open growth of *Pinus strobus* mingling loosely with *Fagus grandifolia*, *B. lenta* and *B. populifolia*. The white pines are short and densely covered with branches almost to the ground. In this vicinity, *Vaccinium atrococcum* and *V. angustifolium* are abundant, as also are *Mitchella repens*, *Lycopodium obscurum* and *L. flabelliforme*. On these steepest parts of the mountain, there is little integrated community development. On the gently rolling mountain top, a red oak-red maple community occurs.

In some places, the zonation is different from that which has just been outlined. Where the slope is gentle, a hemlock-beech community is common all the way to the mountain top where it blends into a white oak-red maple-white pine forest. Hence, it is seen that secondary succession in the ravines has taken many different paths after the lumbering of what was presumably a more or less homogeneous community of hemlock-white pine and northern hardwoods, with perhaps a higher percentage of white pine on the higher slopes.

COMMUNITY ANALYSIS

COMMUNITIES RELATED TO THE OAK-CHESTNUT REGION

Two communities are here described that show relationship to the Oak-Chestnut Region: white oak-red maple and scrub oak. In the large proportion of white oak in the first of these communities, the condition for affinity to the forests of the Oak-Chestnut Region (Illick and Frontz, 1928; Braun, 1950) is definitely fulfilled. Although white oak is scarce in the scrub oak community, the floristic composition of this community shows that it is related to the white oak forests.

White oak-red maple community.—The density and percentage of frequency for all species, and the percentage of the total basal area for tree species over 1 inch d.b.h. in three stands (A, B, and C) of the white oak-red maple community are presented in table 1. Dominant and sub-dominant tree, low shrub and herbaceous strata were present in all stands. The preponderance of *Quercus alba* in the canopy is the outstanding characteristic of this community. This species formed an average of 65.9 per cent of the basal area in the stands analyzed, and had a frequency of 100 per cent. In general, the greatest number of *Q. alba* in each stand were in the 4-9.9 inch size class (fig. 3). Reproductive sizes were also abundant and well distributed. *Acer rubrum* was codominant with *Q. alba*. However, *A. rubrum* showed no fidelity in this region. Figure 2 shows that this species had notable importance value in all the communities studied. Since these communities represent a broad distribution of environmental conditions, it is evident that *A. rubrum* in this region has a wide ecological amplitude. This species formed almost 50 per cent of the tree density, but only 22.7 per cent of the basal area. This is a reflection of the fact that

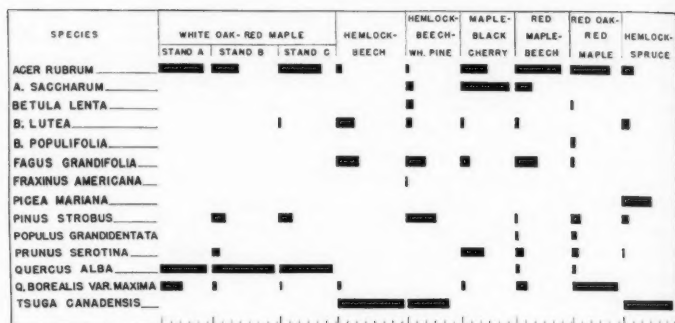


Fig. 2.—A bar graph showing the "importance value" of the dominant trees in the forest communities. The "importance value" index (Curtis and McIntosh, 1951), which was computed by adding the separate percentages of density, frequency and basal area for each species with specimens over 1 inch d.b.h., has a constant value of 300 for each stand. Each full division at the bottom of the graph represents an index value of 25.

most of the red maples were included in the small tree size of 1-3.9 inches. *Quercus borealis* var. *maxima* was present in all stands, but of importance, only in stand A where it formed 19.5 per cent of the basal area.

Pinus strobus was present in all of the white oak forests in the vicinity of Bear Creek, but was scarce or absent in many stands outside of this vicinity. In the two stands studied quantitatively in which it occurred, its average density was 15 and its frequency percentage was 65. The low percentage of basal area formed by this species indicates the small size of the trees. *P. strobus* did not yet form part of the canopy. However, increment borings showed this species to average only 30 years while the deciduous trees among which it became established averaged approximately 65 years. This would suggest that *P. strobus* may form a more important part of these forests in the future.

A dense, subdominant layer of trees composed principally of *Amelanchier arborea*, *Sassafras albidum* and *Hamamelis virginiana* was characteristic of the white oak-red maple community. In some of the stands, these were associated with *Crataegus* sp., *Cornus florida* and *Acer pennsylvanicum* in minor proportions. In all of the stands, the reproductive sizes of *Acer rubrum* contributed heavily to this understory of trees. *Pinus strobus* was also part of it in certain stands.

A very dense, low shrub layer was characteristic of the white oak forests. The ground, to a height of about 1 foot, was covered with ericaceous shrubs, principally *Kalmia angustifolia*, *Vaccinium angustifolium* and *Gaultheria procumbens*. Seedling sizes of *Acer rubrum*, *Quercus alba*, *Quercus borealis* var. *maxima*, *Hamamelis virginiana* and *Sassafras albidum* plus small sprouts of *Castanea dentata* also formed an important part of this layer. Certain other species were of importance in particular stands (table 1). The density of *K. angustifolia*, *V. angustifolium* and *G. procumbens* was unusually high. The vitality of *G. procumbens* was very good, but that of the *Vaccinium* species was poor.

The herbaceous stratum of the white oak-red maple community was well

TABLE 1.—Density and frequency of all species and percentage of basal area of tree species in stands A, B, and C of the white oak-red maple community. The figures are based on sample areas of 1000 sq. m. for trees, 160 sq. m. for shrubs and transgressives, and 10 sq. m. for herbs in each stand.

[illegible]

TABLE I (continued)

| Species | Stand A | | | Stand B | | | Stand C | | |
|----------------------------------|---------|-------------|--------------|---------|-------------|--------------|---------|-------------|--------------|
| | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area |
| <i>Athyrium Filix-femina</i> | | | | | | | X | X | |
| <i>Brachyleytrum erectum</i> | X | X | | 8 | 20 | | | | |
| <i>Carex lucorum</i> | X | X | | | | | | | |
| <i>Clintonia borealis</i> | | | | | | | 11 | 10 | |
| <i>Dennstaedtia punctilobula</i> | | | | | | | X | X | |
| <i>Dryopteris noveboracensis</i> | | | | | | | 18 | 10 | |
| <i>D. spinulosa</i> | X | X | | | | | | | |
| <i>Galium triflorum</i> | X | X | | 2 | 10 | | | | |
| <i>Gaultheria procumbens*</i> | 205 | 80 | | 152 | 90 | | 332 | 100 | |
| <i>Geranium maculatum</i> | X | X | | 3 | 10 | | | | |
| <i>Lycopodium obscurum</i> | | | | | | | 1 | 10 | |
| <i>Lysimachia quadrifolia</i> | 26 | 60 | | 7 | 30 | | 5 | 40 | |
| <i>Maianthemum canadense</i> | 126 | 60 | | 30 | 30 | | 97 | 80 | |
| <i>Medeola virginiana</i> | 8 | 20 | | 6 | 10 | | 14 | 40 | |
| <i>Melampyrum lineare</i> | 1 | 10 | | X | X | | | | |
| <i>Mitchella repens</i> | | | | | | | 15 | 20 | |
| <i>Monotropa uniflora</i> | X | X | | | | | 10 | 20 | |
| <i>Oryzopsis asperifolia</i> | 5 | 20 | | 15 | 40 | | 6 | 50 | |
| <i>Osmunda cinnamomea</i> | | | | X | X | | | | |
| <i>O. claytoniana</i> | | | | | | | 2 | 20 | |
| <i>Panicum spp.</i> | | | | 10 | 20 | | | | |
| <i>Potentilla canadensis</i> | 9 | 10 | | 18 | 30 | | | | |
| <i>Pteridium aquilinum</i> | 13 | 60 | | 17 | 50 | | 13 | 50 | |
| <i>Pyrola rotundifolia</i> | | | | 7 | 20 | | X | X | |
| <i>Smilacina stellata</i> | 4 | 40 | | | | | | | |
| <i>Smilax herbacea</i> | 1 | 10 | | 2 | 20 | | 1 | 10 | |
| <i>Trientalis borealis</i> | 50 | 80 | | 6 | 20 | | 28 | 60 | |
| <i>Trillium undulatum</i> | | | | | | | 2 | 10 | |
| <i>Uvularia sessilifolia</i> | 52 | 70 | | 43 | 90 | | 60 | 90 | |
| <i>Viola pubescens</i> | 2 | 10 | | | | | | | |
| <i>Viola sp.</i> | | | | 2 | 10 | | 2 | 10 | |
| <i>Woodsia obtusa</i> | X | X | | | | | | | |

* Sampled with herbs because of great abundance and small size.

developed, but subordinate to the low shrub layer. Thirty-five species were present, but many of these were of low density and frequency, and some were present in only one of the three stands studied quantitatively. *Uvularia sessilifolia*, *Trientalis borealis*, *Pteridium aquilinum*, *Maianthemum canadense*, *Lysimachia quadrifolia*, *Aralia nudicaulis*, *Amianthium muscaetoxicum*, *Smilax herbacea*, *Medeola virginiana* and *Oryzopsis asperifolia* were present in all of the stands, but were of unequal importance. *Uvularia sessilifolia* and *Maianthemum canadense* were abundant and evenly distributed throughout the community, but rather inconspicuous because of their small size. *Amianthium muscaetoxicum* although of low density and frequency was conspicuous during June because of its tall, 2.5-3 foot, flowering stalks and white flowers. *Pteridium aquilinum* was also evident because of its taller growth. In stand A, the broad, horizontal leaves of *Aralia nudicaulis* formed a covering about a foot

high throughout the stand. While the size of the plants would seem to indicate good vitality, few were in flower or fruit. Five species of fern were present in stand C: *Pteridium aquilinum*, *Dryopteris noveboracensis*, *Dennstaedtia punctilobula*, *Osmunda claytoniana* and *Athyrium filix-femina*. This last was restricted to a moist area in a drainage run, while *O. claytoniana* was restricted to depressions apparently caused by the up-rooting of trees in the distant past.

The soils in the white oak-red maple community were always well drained. The surface of the ground was covered with an inch or two of dry leaves. Mosses were scarce in most stands, but in many places, lichens formed on the dry branches lying on the ground. A 1-2 inch black organic layer penetrated by an abundance of tiny rootlets and underlaid by soil densely filled with the rhizomes of the very abundant ericaceous shrubs was characteristic of this community. The working depth of the roots varied from 13 to 20 inches. The pH of the soil ranged between very strongly and extremely acid (terminology of the Soil Survey staff, 1951). The texture of the soils in stands B and C was loam, except that the lowest horizon in stand B was sandy-loam. The texture in the other stand ranged from a silt-loam in the upper horizons to sandy-loam in the lowest. Large, sandstone rocks were abundant in all of the profiles.

Scrub oak community.—This community with its low, shrubby growth is a problem in the region since it prohibits the establishment of normal forest trees. It is widespread on the crests of hills where its monotonously uniform appearance is broken only by an occasional *Pinus rigida* jutting above the rest of the



Figs. 3, 4.—3. Interior of the white oak-red maple community (stand A). The large trees are white oak; the saplings are red maple. Sassafras seedlings and ericaceous shrubs form much of the ground cover. September 15, 1952. 4. General view of the low, dense growth in the scrub oak community. *Pinus rigida* in the background are only about 20 feet tall. The larger leaves in the center of the picture are *Castanea dentata*. September 15, 1952.

vegetation (fig. 4). The height of the vegetation varies from a little over a foot to more than 10 feet. Within the stand studied quantitatively, the height averaged 4.5 feet. There were three strata: an overstory of dwarfed trees and shrubs, an understory of low shrubs, and an herbaceous layer. As described under the section on methods, these strata were sampled by a line intercept method.

Tall shrubs or dwarfed trees covered 73.9 per cent of the total area. The remaining 26.1 per cent was covered by a dense growth of low shrubs and herbs which also formed a dense cover under the taller shrubs. In the tall shrub layer, *Quercus ilicifolia* was by far the most important species (table 2). *Q. borealis* var. *maxima* and *Q. velutina* were present in very low numbers, but because of their minor importance, and because of the difficulty of identification of the dwarfed, deformed plants in the field, the quantitative data for these species were grouped under *Q. ilicifolia*. This shrub formed 56 per cent of the total tall shrub cover, and had a frequency of 100 per cent. *Comptonia peregrina* formed 22 per cent of the total shrub cover. This plant became more abundant in local areas of very shallow soil, but was widely scattered as is shown by its 100 per cent frequency. *Sassafras albidum* was an important shrub, forming 10.7 per cent of the total cover of the overstory. Much sassafras was only 4 to 5 feet tall yet heavily fruited. It was almost as widespread as *Q. ilicifolia* and *C. peregrina* with a frequency of 100 per cent. Sprouts of *Castanea dentata* were dense in parts of the stand. The role of *Pinus rigida* was minor, only two specimens being encountered on the transects. Other species present in the tall shrub layer are listed in table 2.

A dense and extremely uniform low shrub layer was composed principally of *Vaccinium angustifolium*, *Kalmia angustifolia*, *Gaultheria procumbens*, *Gaylussacia baccata* and *Pyrus floribunda*. The first three of these were also very abundant in the white oak-red maple community. All of these species had a frequency of 100 per cent and very high densities. *V. angustifolium*, while the most abundant, was of low vitality, being small and bearing little fruit. *K. angustifolia* was also small and of low vitality although extremely numerous. *G. baccata* and *P. floribunda*, both very dense and bearing much fruit, were characteristic of this community.

Only thirteen herbaceous species were present. Of these, *Baptisia tinctoria*, often forming clumps that were as tall as the surrounding shrubs, was prominent because of its large size. *Amianthium muscaetoxicum* was likewise notable because of the height and brightness of its flowering stalk in early summer. Its distribution was more uniform than that of *B. tinctoria*. *Melampyrum lineare*, although of high density and 100 per cent frequency, was depauperate and inconspicuous beneath the dense cover of shrubby growth. *Lysimachia quadrifolia* and *Pteridium aquilinum* were evenly dispersed. The three grasses, *Deschampsia flexuosa*, *Danthonia spicata* and *Andropogon scoparius*, listed as present in table 2, were limited to areas of rock outcrops covered by only an inch or two of soil.

The soil depth within this stand varied from a few inches to several feet. On and just beneath the surface of the ground were numerous flat sandstone rocks about a foot long, plus an occasional conglomerate boulder. Some of the rocks, being buried only slightly, were covered with 2 to 4 inches of reddish black organic soil that was densely matted with a great abundance of roots

TABLE 2.—Density, frequency and percentage of overstory cover of the species in the scrub oak stand. Figures are based on ten 10-meter line transects

| Overstory Species | % Overstory Cover | | | Understory Species | | |
|------------------------------|-------------------|-------------|------|---------------------------------|---------|-------------|
| | Density | % Frequency | | | Density | % Frequency |
| <i>Quercus ilicifolia</i> * | 178 | 100 | 56.1 | <i>Vaccinium angustifolium</i> | 503 | 100 |
| <i>Comptonia peregrina</i> | 123 | 100 | 22.0 | <i>Kalmia angustifolia</i> | 388 | 100 |
| <i>Sassafras albidum</i> | 59 | 90 | 10.7 | <i>Gaylussacia baccata</i> | 216 | 100 |
| <i>Castanea dentata</i> | 10 | 30 | 5.0 | <i>Pyrus floribunda</i> | 196 | 100 |
| <i>Acer rubrum</i> | 7 | 10 | 2.3 | <i>Melampyrum lineare</i> | 183 | 100 |
| <i>Pinus rigida</i> | 2 | 20 | 1.6 | <i>Gaultheria procumbens</i> | 103 | 100 |
| <i>Betula populifolia</i> | 3 | 10 | 1.2 | <i>Vaccinium vacillans</i> | 58 | 80 |
| <i>Rhododendron roseum</i> | 5 | 20 | 0.7 | <i>Carex</i> sp. | 56 | 40 |
| <i>Populus grandidentata</i> | 1 | 10 | 0.4 | <i>Pteridium aquilinum</i> | 35 | 80 |
| <i>Hamamelis virginiana</i> | 1 | 10 | 0.1 | <i>Baptisia tinctoria</i> | 23 | 50 |
| <i>Vaccinium stamineum</i> | X | X | | <i>Lysimachia quadrifolia</i> | 18 | 80 |
| <i>Prunus pennsylvanica</i> | X | X | | <i>Amianthium muscaetoxicum</i> | 18 | 70 |
| | | | | <i>Oryzopsis asperifolia</i> | 16 | 20 |
| | | | | <i>Kalmia latifolia</i> | 10 | 30 |
| | | | | <i>Medeola virginiana</i> | 8 | 30 |
| | | | | <i>Aster</i> sp. (rosette) | 7 | 10 |
| | | | | <i>Aralia nudicaulis</i> | 6 | 20 |
| | | | | <i>Amelanchier humilis</i> | 1 | 10 |
| | | | | <i>Deschampsia flexuosa</i> | X | X |
| | | | | <i>Danthonia spicata</i> | X | X |
| | | | | <i>Andropogon scoparius</i> | X | X |

* A few dwarfed and deformed specimens of other species of oaks are grouped here. *Q. ilicifolia* was by far the most important.

and rhizomes. In respect to pH, color and texture, this soil was not unlike that in the white oak-red maple community described previously.

COMMUNITIES RELATED TO THE HEMLOCK-

WHITE PINE-NORTHERN HARDWOODS REGION

The northern hardwood forests which cover broad areas on the Allegheny Plateau were present in this area only in the ravines. The Bear Creek Ravine in particular contained well developed examples of both primary and second-growth forests of this type. Only remnants of primary stands were available for study. These stands, the last examples in this region of the forests that once covered the ravines, were being lumbered as this study was in progress. Secondary succession following the lumbering of the original forests has resulted in the establishment of several different phases of the northern hardwood forests. Three of these were studied quantitatively

Primary Communities

Hemlock-beech and Hemlock-beech-white pine communities.—The primary communities of the ravines were of two types: hemlock-beech and hemlock-beech-white pine. In these communities, tall, straight trunks of *Tsuga canadensis* or *Pinus strobus* with diameters up to 40 inches were topped by a dense canopy. Light intensity was greatly reduced. There was no prominent shrub

TABLE 3.—Density and frequency of all species, and percentage of basal area of tree species in the hemlock-beech and hemlock-beech-white pine communities. Sample areas are the same as in table 1.

| Species | Hemlock-Beech Community | | | Hemlock-Beech- White Pine Community | | |
|--|----------------------------|-------------|--------------|---|-------------|--------------|
| | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area |
| TREES | | | | | | |
| <i>Acer rubrum</i> | 5 | 20 | 1.6 | 2 | 10 | 0.9 |
| <i>Acer saccharum</i> | | | | 5 | 30 | 4.5 |
| <i>Betula lenta</i> | | | | 3 | 30 | 6.6 |
| <i>B. lutea</i> | 12 | 60 | 13.9 | 5 | 20 | 2.6 |
| <i>Fagus grandifolia</i> | 26 | 70 | 12.9 | 19 | 70 | 12.8 |
| <i>Fraxinus americana</i> | | | | 1 | 10 | |
| <i>Pinus strobus</i> | | | | 12 | 50 | 53.2 |
| <i>Quercus borealis</i> var. <i>maxima</i> | 1 | 10 | 1.3 | | | |
| <i>Tsuga canadensis</i> | 101 | 100 | 70.3 | 66 | 100 | 19.4 |
| SHRUBS AND TRANSGRESSIVES | | | | | | |
| <i>Acer rubrum</i> | 7 | 50 | | 3 | 20 | |
| <i>A. saccharum</i> | | | | 20 | 60 | |
| <i>Fagus grandifolia</i> | 12 | 50 | | 74 | 70 | |
| <i>Hamamelis virginiana</i> | 4 | 10 | | X | X | |
| <i>Prunus serotina</i> | | | | 34 | 40 | |
| <i>Rhododendron maximum</i> | 1 | 10 | | | | |
| <i>Rubus</i> sp. | 2 | 10 | | 3 | 10 | |
| <i>Tsuga canadensis</i> | 18 | 60 | | 8 | 80 | |
| HERBS | | | | | | |
| <i>Aralia nudicaulis</i> | X | X | | X | X | |
| <i>Aster divaricatus</i> | X | X | | | | |
| <i>Carex communis</i> | | | | 6 | 10 | |
| <i>C. albicans</i> | | | | X | X | |
| <i>Clintonia borealis</i> | | | | 3 | 10 | |
| <i>Coptis groenlandica</i> | | | | 37 | 10 | |
| <i>Corallorhiza odontorhiza</i> | 4 | 20 | | X | X | |
| <i>Dalibarda repens</i> | X | X | | | | |
| <i>Dennstaedtia punctilobula</i> | X | X | | | | |
| <i>Dryopteris cristata</i> | 51 | 50 | | | | |
| <i>Dryopteris spinulosa</i> var. <i>intermedia</i> | | | | 45 | 70 | |
| <i>Lycopodium lucidulum</i> | X | X | | 10 | 10 | |
| <i>L. obscurum</i> | X | X | | X | X | |
| <i>Maianthemum canadense</i> | 52 | 50 | | 245 | 100 | |
| <i>Medeola virginiana</i> | | | | X | X | |
| <i>Mitchella repens</i> | 1 | 10 | | 15 | 20 | |
| <i>Monotropa uniflora</i> | 4 | 10 | | | | |
| <i>Oxalis montana</i> | 89 | 60 | | 312 | 100 | |
| <i>Polygonatum pubescens</i> | 1 | 10 | | X | X | |
| <i>Polystichum acrostichoides</i> | 5 | 10 | | | | |
| <i>Prenanthes serpentaria</i> | X | X | | | | |
| <i>Trientalis borealis</i> | 7 | 10 | | 21 | 30 | |
| <i>Trillium undulatum</i> | X | X | | X | X | |
| <i>Viola</i> sp. | 3 | 10 | | | | |

or herbaceous layer. The forest floor was covered by a thick mat of conifer needles.

Table 3 indicates the similarity and differences between these two primary communities. The major difference was that *Pinus strobus* was absent from the hemlock-beech community while it formed an important part of the hemlock-beech-white pine community. In this last community, *P. strobus* formed over 53 per cent of the basal area although it formed only 10.6 per cent of the total tree density. It had a frequency of 100 per cent, and occurred in only the two largest size classes: trees 4-9.9 inches and 10 inches or more d.b.h. Some very large specimens occurred within the quadrats. One specimen was 39.5 inches d.b.h. The taller of the pines jutted noticeably above the other trees in the canopy. No reproduction of *P. strobus* was taking place in the community.

Tsuga canadensis had the highest importance value in both communities (fig. 2). In the hemlock-beech community, this species was clearly dominant. It formed almost 70 per cent of the tree density, and over 70 per cent of the basal area. It was present in every size class, and had a frequency of 100 per cent. In all of these characteristics, this community closely resembled the hemlock consociation of Lutz (1930). In the hemlock-beech-white pine community, the hemlock formed a high percentage (58.4) of the tree density, but only 19.4 per cent of the basal area. In this regard it was much subordinate to *P. strobus*. In both communities, reproduction of *T. canadensis* readily takes place in canopy openings, forming small islands of young trees (fig. 5). This indicates that *T. canadensis* would eventually be of increasingly greater sociological importance, and would in all probability replace to a great extent *P. strobus* in the hemlock-beech-white pine community. Hough and Forbes (1943) in work on the Allegheny Plateau noted this tendency for hemlock to replace white pine, and as a result, they regarded the white pine association as a long-lived subclimax, with the hemlock-beech as the climax.

Fagus grandifolia was of similar importance in both of the primary communities. It formed 17.9 per cent of the total tree density in the hemlock-beech community, and 16.8 per cent in the hemlock-beech-white pine. The percentage of basal area that this species formed was almost identical in both of the communities: 12.9 to 12.8 per cent. *F. grandifolia* was abundant as a transgressive (table 3). However, this abundance resulted from suckers that had arisen from the roots of older trees. These shoots were densely shrubby as a result of continuous browsing by deer. This would appear to be an important biotic factor in limiting the future importance of this species.

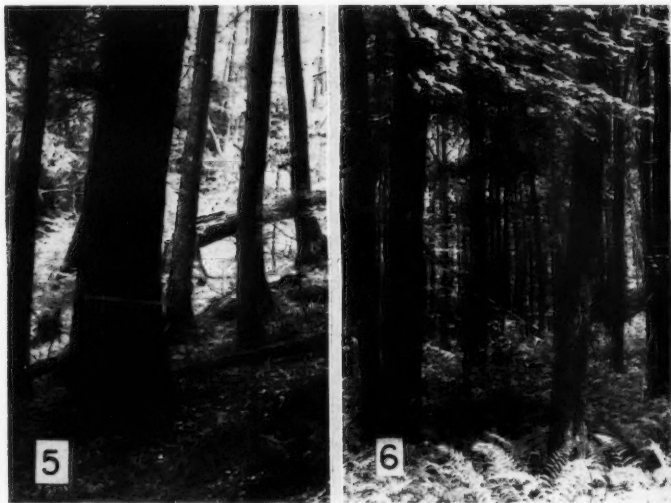
Betula lutea, although somewhat lower in density than *F. grandifolia*, had a slightly higher percentage of the total basal area in the hemlock-beech community. *B. lutea* was not present in the reproductive sizes. Large specimens of both *F. grandifolia* and *B. lutea* were present, many of which, however, were rotting at the center.

The minor importance of *Acer rubrum*, *A. saccharum*, *Betula lenta*, *Fraxinus americana*, *Prunus serotina* and *Quercus borealis* var. *maxima* in the structure of these communities is indicated in table 3. The maple and cherry listed as transgressives were small seedlings. Often young maples were found to have been cut back in one, two or even three successive winters by browsing deer. No young trees were found that were more than three years old.

There was no shrub layer in either of the stands studied. However, in certain of the hemlock-beech stands in the region, especially those occurring on the steep banks of streams, *Rhododendron maximum* sometimes formed a dense undergrowth some 8 to 10 feet tall.

The herbaceous layer was sparse, inconspicuous and composed of comparatively few species. In both communities, *Maianthemum canadense* and *Oxalis montana* were the most abundant and characteristic species. *Dryopteris cristata* was abundant in the hemlock-beech community; and *D. spinulosa* var. *intermedia*, in the hemlock-beech-white pine community. Table 3 gives the density and frequency of the herbaceous species.

Some of the salient features of the soil profile to a depth of 36 inches in the hemlock-beech-white pine stand were as follows. The pH, ranging from 3.8 to 4.6 was the lowest in any of the stands studied. The soil texture was silt loam in the horizons above 8.5 inches, and loam below that level. Large roots formed a dense network just beneath the surface. The upper, organic layer contained a quantity of charcoal indicating that the stand had been influenced by fire. This is in accord with the statement of Lutz (1930) that charcoal is of general occurrence in the superficial soil layers over most of the area occupied by the hemlock-beech association. Soil drainage was fair. At the bottom of the very gentle slope on which this stand was located, there was a small swampy area with the water table at the surface. Large sandstone and



Figs. 5, 6.—5. Interior of the hemlock-beech community. The rod across the trunk of the large hemlock is 36 inches. The other trees in the picture are hemlock, yellow birch and beech. Hemlock reproduction is abundant in the opening caused by the fallen tree in the background. Note characteristic lack of shrub and herbaceous growth. August 22, 1952. 6. Interior of the red maple-beech community. Trees in foreground are red maple and sugar maple. Dense growth of *Dennstaedtia punctilobula* covers the ground. September 10, 1952.

conglomerate rocks lay on the surface of the ground throughout the stand. The soil conditions in the hemlock-beech stand were similar to those described above except for the sandy clay loam texture of a broad horizon from 11 to 29.5 inches. Soil depth in this stand varied considerably due to the erosion and deposition of soil material in different parts of the stand which was on a very steep hillside. In places, large areas of sandstone blocks, often heavily covered by mosses, were exposed.

Second-growth Communities

The original forests of the ravines probably resembled very closely the primary stands just described. After the lumbering of these forests in the late 19th century, secondary forests were initiated which show considerable variation according to topography. A general description of this variation has been presented previously. At this point, a more detailed analysis is given of three communities of these second-growth forests: maple-black cherry, red maple-beech and red oak-red maple.

These three communities are closely related. They have a similarity in tree species composition, but show marked transition in quantitative characteristics. For example, *Acer saccharum* was most abundant at the lower elevations in the ravines (maple-black cherry stand), became much less abundant at slightly higher elevations (red maple-beech stand) and was absent on the dry, rocky summits of the ravines (red oak-red maple stand). *Fagus grandifolia* formed 25.2 per cent of the tree density, and 10.9 per cent of the basal area in the red maple-beech community, but was of less importance in the maple-black cherry stand, and was very insignificant in the red oak-red maple stand. The high density of *F. grandifolia* transgressives (table 4) was due in each case to deer-browsed root suckers. *Prunus serotina* formed 13.4 per cent of the tree density and 30.6 per cent of the basal area in the moister conditions of the maple-black cherry community. But its role in the other two stands, particularly the red oak-red maple stand, was slight. *Quercus borealis* var. *maxima* showed a steady increase in importance value from the maple-black cherry community to the red oak-red maple community where it assumed dominance with 32.3 per cent of the tree density and 58.2 per cent of the basal area. *Acer rubrum* was of considerable importance in these three communities as in the other communities in the region (fig. 2). This substantiates the statement of Illick and Frontz (1928) concerning the abundance of red maple in the transition zones between the northern hardwood forests and the oak-chestnut forests.

In the herbaceous stratum, a dense covering of fern formed another link in the chain of similarities among these communities. These ferns *Dennstaedtia punctilobula* and *Dryopteris noveboracensis* in the maple-black cherry and the red maple-beech stands, and *D. punctilobula* in the red oak-red maple stand gave the forest floor the appearance of a "grassy" pasture. Both species of fern were present in the moister communities, and were often mingled together. However, in the drier, rocky ground of the red oak-red maple community on the crest of the ravine, *D. noveboracensis* was absent. Pound and Egler (1953), in their study of fire line vegetation in southeastern New York, noted the association of these two species, and also the tendency of *D. noveboracensis* to occupy the moister situations. The cover of these ferns was so dense that it greatly controlled the other herbaceous vegetation and even the

shrubby growth. While many species of herbs were able to survive under the fern cover (table 4) almost all were noticeably stunted. Even low shrubs seem unable to compete with the fern.

While these three communities have many characteristics that are similar, table 4 in conjunction with the following descriptions of the individual stands will demonstrate many characteristics that differentiate them.

Maple-black cherry community.—The structure of this even-aged community was simple, consisting of a tree canopy and a herbaceous layer. The three principal species in the arborescent stratum were *Acer saccharum*, *A. rubrum* and *Prunus serotina* (table 4). *Acer saccharum* was the most important tree, having a high density and frequency and forming 44 per cent of the total basal area. *A. rubrum* also formed a considerable portion of the basal area of the stand and was the only tree represented in all of the size classes. *P. serotina* was most abundant in the size class of 10 or more inches d.b.h. Despite a great abundance of seed and of small seedlings, there were almost no transgressives or small trees of this species. *Quercus borealis* var. *maxima*, *Betula lutea* and *Amelanchier arborea* were present but formed no important part of the stand. A few small transgressives of *Fraxinus americana* were also present.

The herbaceous stratum was rather discontinuous, with species tending to be concentrated in certain parts of the stand. *Dennstaedtia punctilobula*, closely associated with *Dryopteris noveboracensis*, was the most important species in regard to both density and frequency. *Carex debilis* was sparingly distributed throughout the stand. *Brachyelytrum erectum* was abundant in a limited portion of the stand. A large, thriving colony of *Adiantum pedatum* occurred closely associated with *Caulophyllum thalictroides*. One poorly drained section of this stand was almost completely devoid of herbaceous cover except for a few specimens of *Viola* spp. and a few depauperate specimens of *Arisaema triphyllum*.

The soil drainage in this stand was rather slow, the soil retaining considerable moisture especially after heavy rains. The upper soil horizon was a 5 inch layer of very rich, organic-mineral silt loam. Roots were most abundant in this upper horizon. From 5 to 21 inches was a layer of reddish brown silt loam which tended to be very moist, especially in the lower part, because below 21 inches was a much compacted loam which was somewhat impervious to water. Fragments of sandstone in varying sizes were present throughout the profile. The uniform pH of 5.2 was the highest of any of the communities studied.

Red maple-beech community.—In this stand, there was a very dense canopy, a sub-canopy layer of *Fagus grandifolia*, a sparse shrub layer and a dense herbaceous layer. While there were nine potentially dominant tree species in the stand, only a few of these formed an important part of the community structure (table 4, fig. 2). *Acer rubrum*, *F. grandifolia* and *A. saccharum* had the highest importance value index numbers. The density of *A. rubrum*, which was more than a quarter of that of the entire stand, resulted from the presence of many trees in the size class 4-9.9 inches d.b.h. This species was also well represented by trees over 10 inches d.b.h., but was absent in the transgressive sizes, except for a few small seedlings. *F. grandifolia* which was most abundant in the 1-3.9 inch size class seemed unable to penetrate the canopy but formed a layer of its own just beneath the canopy. *A. saccharum* was present mostly as a medium sized tree under 10 inches d.b.h. The basal area of

TABLE 4.—Density and frequency of all species, and percentage of basal area of tree species in the maple-black cherry, the red maple-beech and the red oak-red maple communities. Sizes of sample areas are as in table 1.

| Species | Maple- Black Cherry Community | | | Red Maple- Beech Community | | | Red Oak- Red Maple Community | | |
|---------------------------------------|-------------------------------------|-------------|--------------|----------------------------------|-------------|--------------|------------------------------------|-------------|--------------|
| | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area |
| TREES | | | | | | | | | |
| <i>Acer pennsylvanicum</i> | | | | | | | 14 30 | | |
| <i>A. rubrum</i> | 27 60 | 22.1 | | 55 100 | 51.4 | | 48 90 | 25.7 | |
| <i>A. saccharum</i> | 64 80 | 44.0 | | 23 50 | 10.2 | | | | |
| <i>Amelanchier arborea</i> | 4 20 | | | | | | 1 10 | | |
| <i>Betula lenta</i> | | | | | | | 1 10 | | |
| <i>B. lutea</i> | 1 10 | 0.1 | | 3 20 | 1.1 | | | | |
| <i>B. populifolia</i> | | | | | | | 2 20 | 1.4 | |
| <i>Fagus grandifolia</i> | 10 30 | 1.1 | | 32 80 | 10.9 | | 2 10 | 0.5 | |
| <i>Pinus strobus</i> | X X | | | 1 10 | 0.4 | | 5 30 | 7.3 | |
| <i>Populus grandidentata</i> | | | | 1 10 | 2.3 | | 2 20 | 1.7 | |
| <i>Prunus serotina</i> | 16 50 | 30.6 | | 3 30 | 8.7 | | 3 20 | 3.3 | |
| <i>Quercus alba</i> | | | | 1 10 | 3.3 | | 2 10 | 1.9 | |
| <i>Q. borealis</i> var. <i>maxima</i> | 2 10 | 2.1 | | 8 30 | 11.7 | | 31 90 | 58.2 | |
| SHRUBS AND TRANSGRESSIVES | | | | | | | | | |
| <i>Acer pennsylvanicum</i> | | | | X X | | | 20 30 | | |
| <i>A. rubrum</i> | 8 30 | | | 3 10 | | | 2 20 | | |
| <i>A. saccharum</i> | 9 40 | | | 3 30 | | | | | |
| <i>Amelanchier arborea</i> | 1 10 | | | 3 20 | | | 5 40 | | |
| <i>Betula lenta</i> | | | | | | | 2 10 | | |
| <i>Comptonia peregrina</i> | | | | | | | 10 10 | | |
| <i>Crataegus</i> sp. | | | | 2 10 | | | | | |
| <i>Fagus grandifolia</i> | 46 50 | | | 57 90 | | | 6 30 | | |
| <i>Fraxinus americana</i> | 5 30 | | | | | | | | |
| <i>Hamamelis virginiana</i> | | | | 9 20 | | | 15 30 | | |
| <i>Kalmia latifolia</i> | | | | | | | 13 20 | | |
| <i>Parthenocissus quinquefolia</i> | | | | | | | X X | | |
| <i>Prunus serotina</i> | 88 80 | | | 25 70 | | | | | |
| <i>Quercus alba</i> | | | | | | | 4 40 | | |
| <i>Q. borealis</i> var. <i>maxima</i> | 1 10 | | | 1 10 | | | 5 30 | | |
| <i>Rhamnus lanceolata</i> | | | | | | | X X | | |
| <i>Rubus</i> sp. | 6 20 | | | 3 20 | | | | | |
| <i>Vaccinium angustifolium</i> | | | | X X | | | 3 10 | | |
| <i>V. atrococcum</i> | | | | | | | X X | | |
| <i>V. vacillans</i> | | | | 11 10 | | | 15 20 | | |
| <i>Viburnum acerifolium</i> | | | | 3 10 | | | 35 50 | | |
| <i>V. alnifolium</i> | 7 40 | | | | | | | | |
| HERBS | | | | | | | | | |
| <i>Actaea pachypoda</i> | | | | | | | X X | | |
| <i>Adiantum pedatum</i> | 4 10 | | | | | | | | |
| <i>Aralia nudicaulis</i> | | | | | | | 7 30 | | |
| <i>Arisaema triphyllum</i> | 2 10 | | | X X | | | | | |
| <i>Asclepias quadrifolia</i> | | | | X X | | | | | |
| <i>Aster lateriflorus</i> | | | | | | | X X | | |
| <i>Athyrium thelypteroides</i> | 15 10 | | | | | | | | |

TABLE 4 (continued)

| Species | Maple- Black Cherry Community | | | Red Maple- Beech Community | | | Red Oak- Red Maple Community | | |
|--|-------------------------------------|-------------|--------------|----------------------------------|-------------|--------------|------------------------------------|-------------|--------------|
| | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area | Density | % Frequency | % Basal Area |
| <i>Brachyelytrum erectum</i> | 97 | 20 | | 29 | 50 | | 6 | 10 | |
| <i>Calamagrostis cinnoides</i> | | | | | | | X | X | |
| <i>Carex debilis</i> | 29 | 70 | | | | | | | |
| <i>Carex crawfordi</i> | X | X | | | | | | | |
| <i>Carex laxifolia</i> | | | | 20 | 30 | | 5 | 10 | |
| <i>Carex</i> spp. | | | | 6 | 10 | | X | X | |
| <i>Caulophyllum thalictroides</i> | 7 | 10 | | | | | | | |
| <i>Clintonia borealis</i> | | | | X | X | | | | |
| <i>Dalibarda repens</i> | | | | 25 | 50 | | | | |
| <i>Danthonia compressa</i> | | | | 3 | 10 | | 36 | 20 | |
| <i>Dennstaedtia punctilobula</i> | 321 | 80 | | 417 | 80 | | 409 | 80 | |
| <i>Dryopteris marginalis</i> | | | | | | | X | X | |
| <i>D. noveboracensis</i> | 66 | 30 | | 312 | 30 | | | | |
| <i>Galium lanceolatum</i> | | | | | | | 18 | 70 | |
| <i>G. triflorum</i> | X | X | | | | | | | |
| <i>Gaultheria procumbens</i> | | | | | | | 12 | 20 | |
| <i>Hieracium marianum</i> | | | | | | | 1 | 10 | |
| <i>Lobelia inflata</i> | | | | | | | X | X | |
| <i>Lycopodium complanatum</i> var. <i>flabelliforme</i> | | | | 2 | 10 | | X | X | |
| <i>L. lucidulum</i> | | | | 25 | 50 | | | | |
| <i>L. obscurum</i> | X | X | | | | | 18 | 30 | |
| <i>Maianthemum canadense</i> | 33 | 20 | | 28 | 50 | | 17 | 20 | |
| <i>Medeola virginiana</i> | 1 | 10 | | X | X | | 6 | 10 | |
| <i>Mitchella repens</i> | X | X | | 31 | 50 | | 6 | 10 | |
| <i>Monotropa uniflora</i> | | | | X | X | | 8 | 10 | |
| <i>Osmunda cinnamomea</i> | | | | | | | X | X | |
| <i>O. claytoniana</i> | X | X | | X | X | | | | |
| <i>Panicum</i> spp. | | | | X | X | | 12 | 30 | |
| <i>Polygonum scandens</i> | | | | 1 | 10 | | | | |
| <i>Potentilla canadensis</i> | | | | 2 | 10 | | X | X | |
| <i>Prenanthes serpentaria</i> | X | X | | 2 | 10 | | 3 | 10 | |
| <i>Pteridium aquilinum</i> | | | | X | X | | 9 | 30 | |
| <i>Polygonatum biflorum</i> | X | X | | | | | | | |
| <i>Smilax herbacea</i> | X | X | | 1 | 10 | | X | X | |
| <i>Solidago caesia</i> | X | X | | | | | 3 | 10 | |
| <i>Spiranthes gracilis</i> | | | | | | | X | X | |
| <i>Trientalis borealis</i> | 32 | 60 | | 3 | 10 | | | | |
| <i>Trillium undulatum</i> | X | X | | X | X | | 4 | 30 | |
| <i>Uvularia sessilifolia</i> | X | X | | 5 | 20 | | | | |
| <i>Viola</i> spp. | 77 | 60 | | 78 | 60 | | 20 | 50 | |

Prunus serotina was formed principally by a few larger trees. Table 4 gives the density, frequency and percentage of basal area formed by certain other species of trees that were present in minor proportions.

Deer-browsed suckers of *F. grandifolia* formed a stratum about two or three feet high. These and a few plants of *Vaccinium vacillans*, *Viburnum*

acerifolium, and a few shoots of *Hamaemlis virginiana* under a foot tall composed a sparse layer of shrubby plants.

A dense cover of *Dennstaedtia punctilobula* and *Dryopteris noveboracensis* made the herbaceous stratum of this stand very prominent (fig. 6). Table 4 shows the high density of these two species. *Brachyelytrum erectum* (poor quality) was present and widely scattered throughout the stand. While there were some 25 other species present (table 4), they were hidden beneath the dense covering of ferns. Few had been able to thrive; most were dwarfed and non-flowering. The ferns stopped abruptly under the branches of an occasional *Pinus strobus* forming a circle beneath the tree in which *Lycopodium lucidulum*, *Panicum* sp., *Trientalis borealis* and *Vaccinium angustifolium* became more abundant.

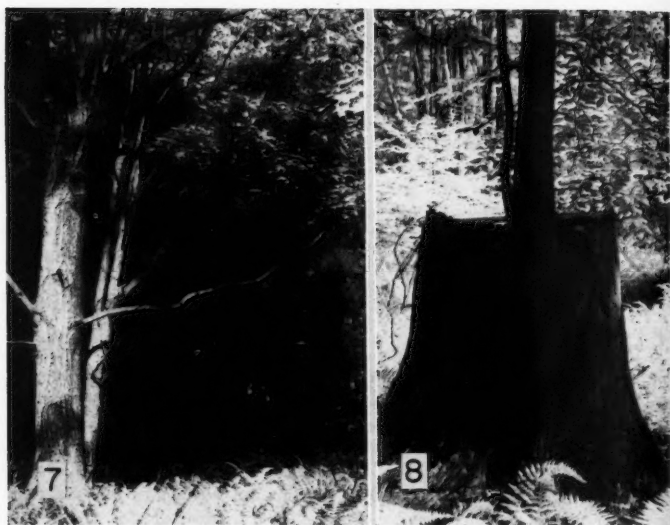
The soil in this stand had been deposited from the adjacent mountain side and was moderately well drained.

Red oak-red maple community.—The openness of the canopy, the high light intensity and a definite subdominant layer distinguished this community from the other second growth communities of the ravines. *Quercus borealis* var. *maxima* and *Acer rubrum* were clearly dominant. Although seven other species were present, their role in the forest composition was minor in comparison with the dominants (table 4). Although the density of *Q. borealis* was less than that of *A. rubrum* (32.3 per cent as compared to 50 per cent), the former species produced 58.2 per cent of the total basal area as compared to 25.7 per cent for *A. rubrum*. While both of these species were represented in four size classes, most of the red oak were trees over 4 inches d.b.h., with a very good proportion being over 10 inches, but red maple was represented by a large proportion of trees under 4 inches d.b.h., and by none over 10 inches. Both species were sparingly present in the transgressive and seedling stages. Most of the trees were of sprout origin. The tree sizes of *Fagus grandifolia*, which were not abundant, formed a part of the canopy, yet, unlike the other deciduous trees, they retained their branches and leaves to within a few feet of the ground as a result of the increased light intensity in this stand. Some of the other trees in the canopy were *Betula lenta*, *Prunus serotina*, *Quercus alba*, *Populus grandidentata* and *Betula populifolia*.

Pinus strobus, while potentially a dominant tree, formed a conspicuous part of the sub-dominant layer. The pine possessed a luxuriant foliage even very low on the trunk (fig. 7). *Acer pennsylvanicum*, growing in clumps of six or more shoots, also formed a conspicuous part of the understory in restricted parts of the stand. *Amelanchier arborea* formed a minor part of the sub-dominant layer. *Rhamnus lanceolata* was present.

There was no very definite shrub layer. *Comptonia peregrina*, with *Pteridium aquilinum* and *Danthonia compressa*, formed patches in small areas where there was only an inch or two of soil. *Kalmia latifolia* (poor quality) apparently browsed by deer, was present in widely scattered clumps. *Vaccinium angustifolium*, *V. vacillans*, *Viburnum acerifolium* and *Hamamelis virginiana* were present as depauperate specimens beneath the dense cover of *Dennstaedtia punctilobula*.

D. punctilobula, with fronds up to three feet tall dominated the herbaceous stratum, and suppressed the other species. *Galium lanceolatum* and *Viola* sp. were the only herbs other than *D. punctilobula* with a frequency of more than 50 per cent. *Brachyelytrum erectum* was often suppressed by the fern, but at



Figs. 7, 8.—7. Interior of the red oak-red maple community. Red oak tree is in foreground. White pine behind the oak shows the luxuriant foliage of this species which forms an understory in the community. The dense herbaceous growth is *Dennstaedtia punctilobula*. September 18, 1952. 8. Detail of one of the white pine stumps described in the text as remaining after the lumbering of the original forest. This stump is 36 inches in diameter. The larger of the two trees growing in the stump is *Betula lenta*, and is 8 inches in diameter. The smaller tree is *Amelanchier arborea*. September 12, 1952.

times, it formed clumps that grew higher than the fern, and produced flowers. Several of the species indicated merely as present in table 4 were found in the more rocky places. Among these were *Actaea pachypoda*, *Dryopteris marginalis*, *Spiranthes gracilis*, *Lobelia inflata*, *Aster lateriflorus*, *Potentilla canadensis*, *Parthenocissus quinquefolia* and a small specimen of *Calamagrostis cinnoides*.

At the western extremity of this stand, huge stumps remaining after the logging of the hemlock and white pine of the original forest were still intact. A whole "grove" an acre or more in extent remained of these soft-wood stumps most of which were over 30 inches in diameter and one of which was 45 inches. The trees that had grown up since the lumbering of the original forests surrounded these stumps. Increment borings of the largest *Quercus borealis* var. *maxima* revealed that this new forest was about 55 to 60 years old, which agrees very closely with that for the other stands in the vicinity. These stumps presented a graphic picture of the original forests that covered the area prior to lumbering, and also showed the present forest to be its immediate successor since no smaller stumps representing a subsequent logging were present. Fire scars on the old stumps gave evidence of past ground fires.

The better preserved of these stumps consisted of a hard outer "shell" of sound wood which was a container for the decayed remains of the interior. This organic matter was dusky red, and was extremely acid. In perhaps 40 to 50 per cent of these stumps, *Betula lenta* had become established and had

grown into sizable trees (fig. 8). Many of these were one to three inches in diameter and some were as much as 8 inches. *B. lenta* was not abundant in the forest surrounding these stumps; however, its seeds are light and easily carried by the wind. As the stumps gradually disintegrated, the roots of the trees growing in them became stilt-like. While *B. lenta* was the characteristic growth in the stumps, *Amelanchier* sp., *Vaccinium atrococcum* and *Osmunda cinnamomea* also thrived in them.

The soil in this stand consisted almost entirely of a broad horizon of sharp-edged sandstone fragments mostly larger than 2 inches, some as large as 6 inches, and a few over a foot in diameter. The particles of soil size formed only about 15 to 20 per cent of this layer. The pH of the soil was 4.8. Drainage was extremely rapid. Roots had spread abundantly through the soil to a depth of 22.5 inches where base rock was encountered.

RELICT COMMUNITIES

Glacially eroded depressions of poor drainage are frequent in the area investigated. The two communities described here are typical of two prominent stages in the succession of bog communities which occur in these depressions.

Blueberry-spruce-larch bog community.—Figure 9 presents the general aspect of this bog community. With only an occasional *Picea mariana* or *Larix laricina* jutting above it, there was a uniform shrub layer about 3 to 5 feet tall throughout the area. A lower stratum of shrubs about 1 foot tall was also present. There were also distinct layers of herbs and mosses.

Sixty-nine per cent of the area was covered by tall shrub and tree growth. *P. mariana* and *L. laricina* were invading the bog and appeared either as widely separated individuals or as small clumps arising above the general level of the tall shrubs. Together these trees formed only 6.6 per cent of the total cover of all woody plants touching the transect line. While it may be expected that these trees will become of increasing importance, there was no evidence in the form of an abundance of seedlings or very young trees to indicate that this will take place very rapidly. Two other tree species were present, but only in a short spindly form: *Acer rubrum* and *Betula populifolia*.

The tall shrub stratum was the most important in the stand. There were several species represented in this layer: *Vaccinium corymbosum*, *V. atrococcum*, *Viburnum nudum*, *Pyrus arbutifolia*, *Ilex laevigata* and *Rhododendron canadense*. *V. corymbosum* and *V. atrococcum* were almost identical in their sociological characteristics. Together they formed about 50 per cent of the total woody cover of the stand, with *V. corymbosum* forming 24.6 per cent, and *V. atrococcum*, 25.9 per cent. The frequency of both species was high. The relatively low densities, as given in table 5, resulted from their presence in large clumps which were counted as single plants. These species were of the highest vitality, bearing many berries. *Chamaedaphne calyculata* was also an important shrub in this community. As table 5 shows, it had an extremely high density and formed a large percentage of the woody cover, yet had a rather low percentage of frequency. It usually occurred in dense, unbroken colonies in localized areas. The high density resulted from the stems arising individually from the rhizomes rather than as clumps. Table 5 presents the density, frequency and percentage of cover for the other tall shrubs.

Kalmia angustifolia and *Vaccinium angustifolium* tended to form a lower



Figs. 9-11.—9. A general view of the blueberry-spruce-larch bog community. The shrubby growth is largely *Vaccinium atrococcum* and *V. corymbosum*. Black spruce and larch are in the background. September 15, 1952. 10. The interior of the hemlock-black spruce bog forest. Sphagnum moss covers the ground and all fallen debris. The largest tree in the center of the picture is hemlock. The tree on the left is black spruce. The fern is *Osmunda cinnamomea*. September 20, 1952. 11. Soil conditions in the hemlock-black spruce forest. Sphagnum moss surrounds the hole from which a few shovels full of earth have been removed. These same ground conditions are typical of the blueberry-spruce-larch bog. The light portion of the measuring rod is about 3.5 inches.

layer that was distinct from the taller shrubs. Together they formed 10.8 per cent of the woody cover, of which *K. angustifolia* formed 8.6 per cent. The vitality of these plants was high. *Vaccinium macrocarpon* and *Rubus hispida* occurred as small vines in the openings between the shrubs.

In the herbaceous stratum, *Eriophorum tenellum* had the highest density and frequency percentage (table 5). The density and frequency of *Osmunda*

TABLE 5.—Density, frequency and percentage of overstory cover of the species in the blueberry-spruce-larch bog community. Figures are based on ten 10-meter transect lines.

| Overstory Species | Overstory Cover | | | Understory Species | | |
|--------------------------------|-----------------|-------------|------|---|---------|-------------|
| | Density | % Frequency | % | | Density | % Frequency |
| <i>Vaccinium atrococcum</i> | 33 | 100 | 25.9 | <i>Eriophorum tenellum</i> | 172 | 100 |
| <i>V. corymbosum</i> | 32 | 90 | 24.6 | <i>Smilicina trifolia</i> | 134 | 80 |
| <i>Chamaedaphne calyculata</i> | 89 | 40 | 16.3 | <i>Osmunda cinnamomea</i> | 103 | 90 |
| <i>Kalmia angustifolia</i> | 50 | 100 | 8.6 | <i>Lysimachia terrestris</i> | 69 | 80 |
| <i>Betula populifolia</i> | 14 | 90 | 4.6 | <i>Carex folliculata</i> | 48 | 60 |
| <i>Picea mariana</i> | 4 | 40 | 3.5 | <i>Juncus brachycephalus</i> | 27 | 30 |
| <i>Viburnum nudum</i> | 11 | 40 | 3.5 | <i>Dulichium arundinaceum</i> | 27 | 10 |
| <i>Nemopanthus mucronata</i> | 10 | 60 | 3.2 | <i>Rubus hispidus</i> | 26 | 40 |
| <i>Larix laricina</i> | 3 | 30 | 3.1 | <i>Vaccinium macrocarpon</i> | 22 | 20 |
| <i>Vaccinium angustifolium</i> | 19 | 40 | 2.2 | <i>Sarracenia purpurea</i> | 6 | 50 |
| <i>Pyrus arbutifolia</i> | 9 | 40 | 1.5 | <i>Coptis groenlandica</i> | 3 | 10 |
| <i>Acer rubrum</i> | 6 | 40 | 1.2 | <i>Scirpus atrocinctus</i> | 3 | 10 |
| <i>Ilex laevigata</i> | 7 | 20 | 0.8 | <i>Juncus canadensis</i> | 5 | 10 |
| <i>Rhododendron canadense</i> | 1 | 10 | 0.5 | <i>Calamagrostis cinnoides</i> | 1 | 10 |
| <i>Viburnum dentatum</i> | 1 | 10 | 0.2 | <i>Carex trisperma</i> | ∞ | 100 |
| | | | | <i>Sphagnum</i> sp. | ∞ | 100 |
| | | | | <i>Polytrichum</i> sp. | ∞ | 100 |
| | | | | <i>Glyceria canadensis</i> | X | X |
| | | | | <i>Leucothoe racemosa</i> | X | X |
| | | | | <i>Carex crinita</i> var. <i>gynandra</i> | X | X |
| | | | | <i>Eriophorum vaginatum</i> L. | X | X |
| | | | | <i>Aster acuminatus</i> | X | X |

cinnamomea was also high. In early June, the fronds of this fern showing the heavy, thick structure of leaves exposed to bright sunlight, had already turned brown about the edges and seemed to be dying. However, in September, their condition had not changed perceptibly. In June, a few specimens of *Eriophorum vaginatum* L., most of which had already dropped their seed, were observed. *Carex trisperma*, an extremely fine, delicate sedge, was most abundant. No attempt was made to count this species because of its great number and small form. Table 5 gives the density and frequency percentage of the other herbaceous species in this bog.

The very thick layer of sphagnum and *Polytrichum* moss, covering all unoccupied ground, was one of the prominent features of the community. To a certain extent, the sphagnum and *Polytrichum* intermingled, but there was a strong tendency for the sphagnum to grow in the lower, wetter places and for the *Polytrichum* to be confined to small mounds that formed particularly about the bases of the shrubs.

The clay soil beneath the moss was black in color, and had a pH of 4.4. The lag about the margin of the bog was distinguishable by its smaller number of shrubs and by the abundance of *Calamagrostis cinnoides* and *Rubus hispidus*. *Cornus canadensis* was also present in this area.

Hemlock-black spruce bog community.—In the bog forests of the area, hemlock, black spruce and red maple formed a dense growth. The water

table in most places was immediately beneath a thick, luxuriant mat of sphagnum moss which almost completely covered the ground as well as fallen logs and other debris (figs. 10, 11). Ecological conditions within this community were heterogeneous. In places, the soil was dry at least on the surface. In such places, a dense tree growth made conditions unfavorable for herbs. Wind-falls were extremely common because of the soft, yielding nature of the soil. This created conditions in limited areas of greatly increased light intensity where the species composition of the shrub and herbaceous vegetation was different from that which surrounded it. Large pools of water often formed in the depressions beneath the upturned roots of fallen trees. All of this resulted in diverse ecological conditions favorable for a localized distribution of a large number of species. Increment borings showed the stand described below to be approximately 65 to 70 years old.

The tree stratum of this bog forest was composed principally of three

TABLE 6.—Density and frequency of all species, and percentage of basal area of tree species in the hemlock-black spruce bog community. Sample areas are the same as in table 1.

| Species | Density | % Frequency | % Basal Area | Species | Density | % Frequency |
|---------------------------------------|---------|-------------|--------------|---|---------|-------------|
| TREES | | | | HERBS | | |
| <i>Acer rubrum</i> | 25 | 60 | 6.3 | <i>Agrostis scabra</i> var. <i>geminata</i> | X | X |
| <i>Betula lutea</i> | 9 | 60 | 0.6 | <i>Aralia nudicaulis</i> | 1 | 10 |
| <i>Picea mariana</i> | 70 | 100 | 28.9 | <i>Arisaema triphyllum</i> | 1 | 10 |
| <i>Pinus strobus</i> | 6 | 50 | 3.6 | <i>Aster acuminatus</i> | 15 | 10 |
| <i>Prunus serotina</i> | 1 | 10 | 0.1 | <i>Bidens connata</i> | X | X |
| <i>Tsuga canadensis</i> | 151 | 100 | 60.5 | <i>Calla palustris</i> | 16 | 30 |
| <i>Amelanchier arborea</i> | 1 | 10 | | <i>Carex crinita</i> var. <i>gynandra</i> | X | X |
| <i>Rhamnus lanceolata</i> | X | X | | <i>C. folliculata</i> | 4 | 10 |
| SHRUBS AND TRANSGRESSIVES | | | | <i>C. trisperma</i> | 162 | 80 |
| <i>Acer rubrum</i> | 19 | 90 | | <i>Clintonia borealis</i> | 26 | 20 |
| <i>Alnus rugosa</i> | 4 | 10 | | <i>Coptis groenlandica</i> | 143 | 40 |
| <i>Amelanchier arborea</i> | 6 | 30 | | <i>Cornus canadensis</i> | 2 | 10 |
| <i>Betula lutea</i> | 2 | 20 | | <i>Dryopteris cristata</i> | X | X |
| <i>Ilex montana</i> | 1 | 10 | | <i>D. noveboracensis</i> | 7 | 10 |
| <i>Kalmia latifolia</i> | 6 | 10 | | <i>D. simulata</i> | 37 | 20 |
| <i>Nemophanus mucronata</i> | 1 | 10 | | <i>Glyceria melicaria</i> | X | X |
| <i>Picea mariana</i> | 16 | 60 | | <i>G. striata</i> | X | X |
| <i>Pyrus arbutifolia</i> | 4 | 10 | | <i>Juncus brachycephalus</i> | 13 | 20 |
| <i>Quercus alba</i> | 1 | 10 | | <i>Lycopus rubellus</i> | 25 | 10 |
| <i>Q. borealis</i> var. <i>maxima</i> | 2 | 20 | | <i>Lysimachia terrestris</i> | 16 | 20 |
| <i>Rubus</i> sp. | 9 | 10 | | <i>Maianthemum canadense</i> | 3 | 10 |
| <i>Sorbus americana</i> | 2 | 10 | | <i>Medeola virginiana</i> | X | X |
| <i>Tsuga canadensis</i> | 36 | 90 | | <i>Mitchella repens</i> | 1 | 10 |
| <i>Vaccinium angustifolium</i> | 13 | 30 | | <i>Osmunda cinnamomea</i> | 32 | 30 |
| <i>V. atrococcum</i> | 12 | 20 | | <i>Oxalis montana</i> | 8 | 10 |
| <i>Viburnum dentatum</i> | 8 | 40 | | <i>Polygonum arifolium</i> | 1 | 10 |
| <i>V. nudum</i> | 4 | 20 | | <i>Pteridium aquilinum</i> | X | X |
| | | | | <i>Trientalis borealis</i> | 24 | 40 |
| | | | | <i>Trillium undulatum</i> | 1 | 10 |
| | | | | <i>Viola</i> sp. | 2 | 10 |

species: *Tsuga canadensis*, *Picea mariana* and *Acer rubrum*. *T. canadensis* was by far the most important as is shown by table 6. This tree formed 57.6 per cent of the total tree density and over 60 per cent of the total basal area. It was distributed throughout the stand and was present in all the size classes, being particularly abundant as a tree under 10 inches d.b.h. although a number of trees larger than this were present. *P. mariana*, a codominant in the stand, formed only about half the percentage of density and basal area of *T. canadensis*. *P. mariana* was particularly abundant as a tree between 4 to 10 inches. *A. rubrum* was of considerably less sociological importance than the two species just described (fig. 2). It formed only 6.3 per cent of the total basal area, being most abundant as a tree under 4 inches d.b.h. An occasional *Pinus strobus* also formed a part of the canopy layer; this was true even in the very moist locations. It was most frequently found as a tree in the 4-9.9 inch size class. As indicated by fig. 2, *Betula lutea*, *Prunus serotina*, *Quercus borealis* var. *maxima* and *Q. alba* were present in the stand, but formed no important part of it. Dead trunks or stumps of *Betula populifolia* were frequently encountered. Their presence indicated that this species invaded after lumbering but subsequently has been suppressed. A few specimens of *Amlanchier arborea* were present but mostly as small transgressives.

There was no consistent shrub layer, but in certain places, particularly those of increased light intensity, it was quite dense and high. In such places, shrub species such as the following flourished: *Viburnum dentatum*, *V. nudum*, *Vaccinium atrococcum*, *Pyrus arbutifolia*, *Nemophanthus mucronata* and *Alnus rugosa*. Where the tree canopy was unbroken, there was no prominent shrub layer.

The low densities and frequencies of the herbaceous species as given in table 6 indicate the heterogeneity of this layer. As remarked above, this condition resulted from the presence of a variety of habitats available to the various species. *Carex trisperma*, the only herb with a fairly high frequency percentage, mingled everywhere with the sphagnum. *Calla palustris* grew particularly in the pools of water that gathered in the holes opened by the roots of wind-throws. *Osmunda cinnamomea* grew profusely under the openings in the canopy in high, firm tussocks with fronds 3 or 4 feet long. *Lysimachia terrestris* was present in the very wet areas. All such conditions as these account for the heterogeneity of the herbaceous stratum. Soil removed from the well shown in figure 11 was almost pure clay of a dark reddish brown color and of pH 4.6.

SUMMARY

On the Pocono Plateau adjacent to the anthracite coal fields in northeastern Pennsylvania, a phytosociological analysis was made of some of the plant communities during parts of 1951 and 1952. This area has been subjected to intensive lumbering because of the ready market for all sizes of timber for use in the coal mines.

Quantitative data were secured for the various strata in the forest communities by means of quadrat sampling. Density and frequency for trees, shrubs and herbs, and basal area for dominant tree species were determined. A line transect method was used in the shrub communities to determine the density and frequency of all species, and the cover of the overstory species.

This region, being transitional between the hemlock-white pine-northern

| Density | Frequency |
|---------|-----------|
| % | % |
| X | X |
| 1 | 10 |
| 1 | 10 |
| 15 | 10 |
| X | X |
| 16 | 30 |
| X | X |
| 4 | 10 |
| 162 | 80 |
| 26 | 20 |
| 143 | 40 |
| 2 | 10 |
| X | X |
| 7 | 10 |
| 37 | 20 |
| X | X |
| X | X |
| X | X |
| 13 | 20 |
| 25 | 10 |
| 16 | 20 |
| 3 | 10 |
| X | X |
| 1 | 10 |
| 32 | 30 |
| 8 | 10 |
| 1 | 10 |
| X | X |
| 24 | 40 |
| 1 | 10 |
| 2 | 10 |

hardwood forests and the more southern oak-chestnut forests, supported communities related to both of these forest regions. The most extensive community in the study area was the white oak-red maple. It was present in the more mesic situations, forming a matrix about the other communities. A great abundance of white oak and red maple in the canopy, the presence of *Amelanchier arborea*, *Hamamelis virginiana* and *Sassafras albidum* in the sub-dominant stratum, and a dense, low shrub layer of *Kalmia angustifolia*, *Vaccinium angustifolium* and *Gaultheria procumbens* characterized this community. In certain stands, *Pinus strobus* gave indications of future importance.

A scrub oak community was common on the broad hilltops. *Quercus ilicifolia* formed 56 per cent of the tall shrub cover in this community. *Comptonia peregrina* and *Sassafras albidum* were also important. A low, ericaceous shrub layer was very dense beneath the taller shrubs. Only thirteen herbaceous species were present.

In the steep ravines and along streams, communities related to the Hemlock-White Pine-Northern Hardwoods Region were common. Quantitative data were obtained for both the primary and second-growth forests of these ravines. The primary communities were designated as hemlock-beech and hemlock-beech-white pine. Hemlock was dominant in these primary communities of which only a few remnants remained in the region. White pine formed 53 per cent of the basal area in one of the stands, but in this stand, as in the hemlock-beech stand, the lack of white pine reproduction and the abundance of hemlock reproduction indicated an ever increasing importance of the latter in such communities.

Second-growth communities of the ravines varied considerably with the topography. Analysis was made of maple-black cherry and red maple-beech communities as they occurred at the lower elevations, and of a red oak-red maple community occurring on the ravine crests. The wide ecological amplitude of red maple in this region has resulted in its presence and importance in all of the second-growth forests.

Relict communities were present in the poorly drained areas. A blueberry-spruce-larch bog community and a hemlock-black spruce forest were prominent stages in the succession of bog communities. *Vaccinium atrococcum* and *V. corymbosum* formed 50 per cent of the cover in the former, while hemlock formed 60 per cent of the basal area in the latter.

The soil in the various communities varied from strongly to extremely acid. That of the hemlock-beech-white pine community was the most acid of those studied (pH 3.8 to 4.6). In texture, the soils were predominantly loams, but varied from silty clay loam to sandy loam.

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Lichens from Baffin Island¹

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In the summer of 1950 the author took part in an expedition of the Arctic Institute of North America to Baffin Island, Northwest Territories, Canada. This was the first scientific expedition of its kind to study intensively in the Canadian Eastern Arctic at one locality for an entire season, with the center of activity around Clyde Inlet. In addition the author was able to make brief visits to several other stations on the island: Arctic Bay, Pond Inlet, Clyde, Barnes Ice Cap (at Camp A2), Cape Searle, and Frobisher Bay (fig. 1).

During the expedition the author had ample opportunity to make careful studies of the lichen flora at some of the above localities. This was especially desirable since Baffin Island, which itself forms the major land mass of the Canadian Eastern Arctic, has been virtually the last remaining *terra incognita* of lichenology in the arctic. A review of the history of lichen exploration in the area, already covered fully by Lynge (in Polunin, 1947), will show at once that a lichenologist has never visited the island. In fact our knowledge of its flora before 1934 rested on incidental collections of less than 60 of the commonest arctic species, often identified by amateurs. During 1934 and 1936 Dr. Nicholas Polunin investigated a number of stations on Baffin Island and in spite of other botanical duties returned with a surprisingly large number of lichens, subsequently identified by Lynge, who was the foremost authority on the arctic lichen flora.

These collections, however, were made chiefly at the well traveled coastal stations and included with few exceptions the more common arctic species. The author was fortunate in revisiting most of these areas and also in exploring several fiord heads, the interior of the island, and the Cape Searle bird cliffs. The number of critical lichen species collected must prompt us to reconsider the phytogeographical position of Baffin Island; indeed the diversity of species should place this neglected area among the most interesting of arctic regions.

Lichenological research on Baffin Island has now provided us with a workable knowledge of the macrolichen flora. The microlichens are of course still incompletely known but appear representative for the area. The information accumulated thus far should form a suitable basis for a preliminary study of the lichen flora of Baffin Island, which will include the author's collections along with reports of specimens examined by Lynge (1932b, 1935, 1939; in Polunin, 1947). All other literature reports given by Lynge will be ignored since they have not been verified in recent times. Brief notes on the habitats of many species will be added, as the author considers this information of distinct value. Keys will also be constructed for the more completely represented genera.

¹ The field studies were made possible by the Arctic Institute of North America, under whose auspices the author accompanied the expedition as assistant botanist. Examination of the field material was supported in part by a grant from the Wisconsin Alumni Research Foundation.

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GEOLOGY AND CLIMATE OF BAFFIN ISLAND

The geology of nearly all stations has already been discussed by Polunin (1948) in a full manner with numerous photographs, and this information will not be repeated here. A few notes on the areas not seen by him should be of interest, although some of these are described in the preliminary reports of the expedition (Baird et al., 1950; Baird, 1951).

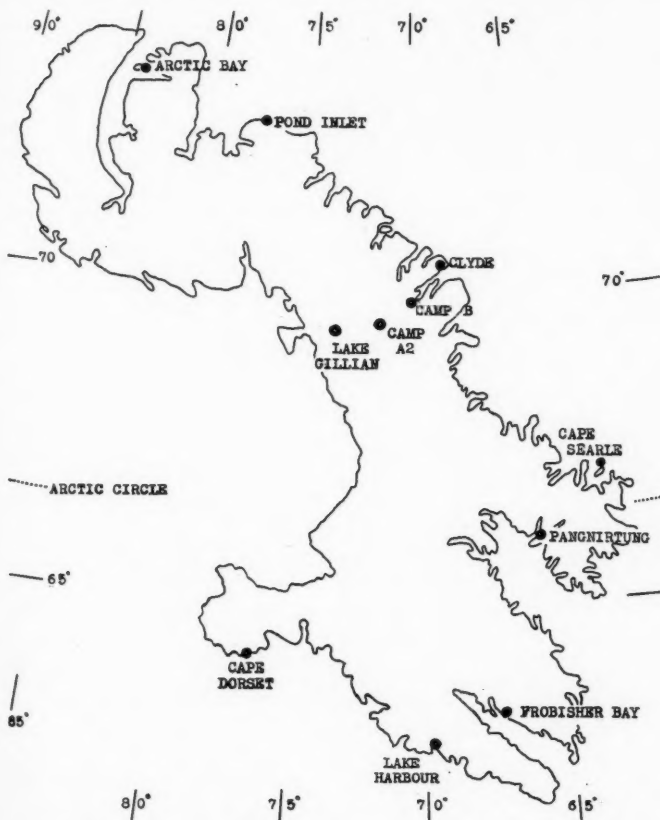


Fig. 1.—Sketch map of Baffin Island showing locations of stations visited by various collectors. Albert Harbour, Mitimatalik, and Qilalukan are all adjacent to Pond Inlet. Camp B lies at the head of Clyde Inlet.

The head of Clyde Inlet or Camp B is composed principally of gneisses with diabase dikes. About 4 km. inland is a large intrusion of marble which seems to occur at all fiord heads in the region. Cape Searle is a narrow exposed island about 3 km. long, the western half of which is a large columnar intrusion of volcanic sediments, principally phonolite with varied mineral inclusions. There was a fulmar petrel colony of considerable size on these precipitous cliffs where a number of nitrophilous lichens were found. The interior of the island around Barnes Ice Cap, lying at about 300 m. elevation, has subdued hills of gneiss with some outcrops of magnetite and quartzite.

The nature of the bedrock has a considerable influence on the lichen flora. Most of the stations underlain by acidic rocks have a relatively rich lichen flora. Arctic Bay, in a region of limestones, has a very small flora, lacking for example most of the common *Cladoniae*. Calciphilous lichens in general seemed quite rare.

The monthly mean temperatures for three stations, Arctic Bay, Clyde, and Frobisher Bay, based on official weather records (Henry and Armstrong, 1949) for a period of 2-4 years, are given in table 1. All of these areas have low annual precipitation, 17.4, 14.6, and 24.3 cm. respectively.

TABLE 1.—Monthly mean temperatures for three weather stations on Baffin Island.

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | |
|---------------|-------|-------|-------|-------|-------|-------|-------|
| Arctic Bay | -28.7 | -32.8 | -27.3 | -19.9 | -7.2 | 1.9 | |
| Clyde | -25.4 | -26.8 | -24.5 | -19.2 | -6.9 | 0.6 | |
| Frobisher Bay | -24 | -28.2 | -23.4 | -14.7 | -3.9 | 2.4 | |
| | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
| Arctic Bay | 6.3 | 4.9 | -1.1 | -9.8 | -21.2 | -27.7 | -13.5 |
| Clyde | 3.9 | 3.9 | 0 | -5.9 | -16.3 | -22.6 | -11.6 |
| Frobisher Bay | 7.1 | 6.2 | 1.3 | -4.6 | -11.3 | -20.1 | -9.4 |

These stations are probably representative of similarly situated areas on the island. Arctic Bay has a continental climate typical of fiord heads along the mountainous eastern coast (cf. Montgomery in Baird et al., 1950, for Clyde Inlet). Clyde has a more oceanic climate as evidenced by the cool summer; similar conditions prevail at Cape Searle. Frobisher Bay resembles other southern stations in having higher summer temperatures and more precipitation than the northern ones. Polunin (1948) gives additional data for most of the other stations on Baffin Island.

Although Baffin Island does not lie at a high altitude, the general atmospheric and oceanic circulation makes it much cooler than other land masses at the same latitude. For example the west coast of Greenland has monthly temperatures up to 14° C. higher than the east coast of Baffin Island directly opposite. These climatic differences probably affect the lichen flora to a great extent.

LICHEN PHYTOGEOGRAPHY

The distribution of lichens in arctic North America is so incompletely known that detailed comparisons with other arctic or alpine regions are im-

possible. The following summary, however, can be usefully compared with the results of Dahl (1950) in southwest Greenland and Lynge (1940) in northeast Greenland.

The majority of lichens occurring on Baffin Island are common to all arctic lands and circumpolar in distribution. This includes about 230 or 90 per cent of the 257 species in the present list. On the other hand there is a significant number of eastern species (Novaya Zemlya east through arctic North America) which have not yet been found in the western arcto-Atlantic sector (Greenland, Scandinavia), including

Cetraria chrysantha
C. nigricans
Endocarpon tortuosum
Evernia perfragilis

Parmelia separata
Stereocaulon glareosum var. *corymbosulans*
S. leprocephalum
Sticta arctica

These species point to a strong eastern element in the lichen flora, further emphasized by the apparent lack on Baffin Island of many typical Scandinavian species, for instance *Arctomia delicatula* and *Leciophysma finmarkicum*, both present in Greenland.

The following species were previously known only from the Old World (Scandinavia, Europe).

Ionaspis spitsbergensis
Lecania alpivaga
Lecanora caesiopruinosa
Lecidea homosema

Pertusaria octomela
Stereocaulon capitellatum
Umbilicaria aprina

Assuming that Greenland is reasonably well explored, this type of distribution is difficult to account for.

Baffin Island has several endemic species, including *Lecanora canadensis*, *L. superfluens*, and *Lecidia baffiniana*.

A final group of species is known only from Greenland and North America: *Lecanora maxima*, *L. pertusa*, *Lecidea cyanesens*, *Parmelia centrifuga* var. *groenlandica*.

Baffin Island is highly interesting from the standpoint of phytogeography. The collector is rewarded by finds of many supposedly endemic or otherwise rarely discovered lichen species which often form a conspicuous part in the lichen vegetation. An intensive study of many contiguous stations as Dahl conducted in southwest Greenland would reveal many more unexpected finds. With some idea of the phytogeographical position of Baffin Island it is obvious that the attention of American lichenologists should be directed to the continental Northwest Territories, where the lack of lichen collecting presents a major gap in our knowledge of lichen distribution. Llano's (1951) recent studies in northern Alaska have brought to light many interesting species unknown from that region before.

THE LICHEN FLORA

Collections made during the expedition now bring the number of species definitely known from Baffin Island to 257,² representing an increase of 97 over all previous lists. The author collected altogether 226 species and the

² Additions and corrections to this number made during publication are summarized in the addendum and should be consulted both for this section and for lichen phytogeography.

remainder are literature reports of specimens examined by Lynge. The numbers collected at the individual stations are as follows: Arctic Bay, 65; Mitimatalik (with Albert Harbour, Janes Creek, and Qilalukan), 26; Pond Inlet, 87; Clyde, 50; the head of Clyde Inlet in the vicinity of Camp B, 196; Barnes Ice Cap, 62; Cape Searle, 75; Totnes Road, 9; Pangnirtung, 55; Frobisher Bay, 50; Lake Harbour, 64; Cape Dorset, 47. Dr. Dansereau collected some species on the Foxe Basin Coast and these are listed in the addendum. Unequal collecting is very apparent and chiefly reflects the amount of time spent at each station: at Clyde Inlet more than 40 days; at Barnes Ice Cap, Cape Searle, and Frobisher Bay less than 2 days each; and at the remaining stations a few hours at the most but by several different collectors.

The following entities are new to science: *Evernia perfragilis* f. *soredica* Hale, n. f. *Stereocaulon glareosum* var. *corymbosulans* M. Lamb, n. var.

Diagnoses of *Lecanora superfluens* n. sp. and *Lecidia baffiniana* n. sp. were recently published independently by Dr. A. H. Magnusson (1952).

Additions and corrections to this number made during publication are summarized in the addendum and should be consulted both for this section and for lichen phytogeography.

The following 19 species are new to the continent of North America.

| | |
|--------------------------------|----------------------------------|
| <i>Acarospora montana</i> | <i>Lecidea cyanescens</i> |
| <i>Cetraria nigricascens</i> | <i>L. homosema</i> |
| <i>Ionaspis spitsbergensis</i> | <i>Ochrolechia grimmiae</i> |
| <i>Lecania alpivaga</i> | <i>Pannaria isidiata</i> |
| <i>Lecanora caesiopruinosa</i> | <i>Pertusaria ootomela</i> |
| <i>L. maxima</i> | <i>Physcia lithotodes</i> |
| <i>L. pertusa</i> | <i>Rhizocarpon expallesces</i> |
| <i>L. sublapponica</i> | <i>Stereocaulon capitellatum</i> |
| <i>Lecidea cuprea</i> | <i>S. leprocephalum</i> |
| | <i>Umbilicaria aprina</i> |

The following 44 species and 2 varieties are new to the Canadian Eastern Arctic.

| | |
|---|--|
| <i>Acarospora badiofusca</i> | <i>Leptogium saturninum</i> |
| <i>Bacidia muscorum</i> | <i>Microglæna sphinctrinoides</i> |
| <i>Baeomyces placophyllus</i> | <i>Nephroma expallidum</i> |
| <i>Buellia scabrosa</i> | <i>Pannaria hookeri</i> |
| <i>Caloplaca cirrochroa</i> | <i>P. pezizoides</i> |
| <i>C. festiva</i> | <i>Parmelia exasperatula</i> |
| <i>Cladonia subcervicornis</i> | <i>Parmeliella lepidiota</i> |
| <i>Dermatocarpon hepaticum</i> | <i>Peltigera polydactyla</i> |
| <i>Endocarpon tortuosum</i> | <i>Pertusaria bryontha</i> |
| <i>Ephebe lanata</i> | <i>Physcia constipata</i> |
| <i>Evernia perfragilis</i> | <i>P. sciastra</i> |
| <i>Ionaspis epulotica</i> var. <i>arctica</i> | <i>Polychidium muscicola</i> |
| <i>Lecanora alphoplaca</i> | <i>Rhizocarpon occidentale</i> |
| <i>L. atrosulphurea</i> | <i>Rinodina bischoffii</i> |
| <i>L. behringii</i> | <i>Solorina spongiosa</i> |
| <i>L. castanea</i> | <i>Staurothele clopima</i> |
| <i>L. lacustris</i> | <i>Stereocaulon glareosum</i> |
| <i>L. melanaspis</i> | <i>S. vesuvianum</i> var. <i>glaucescens</i> |
| <i>L. sordida</i> | <i>Umbilicaria cinereofuscens</i> |
| <i>Lecidea demissa</i> | <i>U. deusta</i> |
| <i>L. glomerulosa</i> | <i>Verrucaria ceuthocarpa</i> |
| <i>L. pelobotryon</i> | <i>V. rupestris</i> |
| <i>Leptogium lichenoides</i> | <i>Xanthoria fallax</i> |

In the identification of specimens the author had access to a large amount of herbarium material for comparison, including partial exsiccatae of Dahl, Lynge, Magnusson, and Malme, in addition to the aid from specialists which has already been acknowledged. There remains to be sure a considerable unidentified material for which no comparison specimens were available.

General distribution is cited only for species with a restricted range according to our present knowledge; for most of the species are circumpolar and range southward in alpine situations, as may be deduced from the numerous lists of arctic species. Greenland is not considered here a part of North America for both phytogeographical and political reasons. Many of the author's statements of species new to North America or the Canadian Eastern Arctic may be questioned, although they are usually made with some reserve. May a few errors stimulate further research on North American lichens! As Simmons' large Ellesmere collections are slowly redetermined, some statements of new records will become invalidated. A complete revision of Simmons' material is especially necessary for lichenological studies in the Canadian arctic, and it is much to be hoped that this task will be undertaken soon by those who have access to it.

Several abbreviations for collectors' names are used in the list: B—specimen collected by Bazin; P—Polunin, both of these in Polunin (1947); D—Dutilly (Lynge, 1939); S—Seidenfaden, Godthaab Expedition (Lynge, 1932b, overlooked by Lynge himself (in Polunin, 1947); T—Thule Expedition (Lynge, 1935). The author's specimens are cited by the packet number. A complete set of the specimens is deposited in the National Herbarium of Canada and in the herbarium of the University of Wisconsin; partial sets are being distributed to a number of lichenologists.

Literature citations for the individual species are given only in certain interesting cases. The nomenclature throughout is after Lynge in his numerous arctic papers, unless stated to the contrary.

ANNOTATED LIST OF SPECIES

VERRUCARIACEAE

The pyrenocarpous lichens are poorly represented in the following list although a few have not yet been determined. The marine species suffer considerably from ice abrasion.

1. *Verrucaria* cf. *ceuthocarpa* Wahlb.—Clyde Inlet (711). On gneiss rocks just below high tide level, common. The thallus is typical but very scattered and confined to small cracks in the rocks. Perithecia are rare, spores $7-10 \times 5-7 \mu$. New to the Canadian Eastern Arctic.
2. *Verrucaria rupestris* Schrad.—Pond Inlet (552). On limestone, common. Thallus disappearing, perithecia numerous, up to 4 mm. Apparently new to the Eastern Arctic.
3. *Polyblastia bryophila* (Nyl.) Lönnr.—Clyde Inlet (570). Over mosses and plant remains, scarce. New to Baffin Island but previously collected on Ellesmere.
4. *Polyblastia hyperborea* Th. Fr.—Cape Dorset (P).
5. *Staurothele clopima* (Wahlb.) Th. Fr.—Cape Searle (757). On gneiss rocks in stream beds, common. The rather thick uniform thallus excludes *S. fuscocuprea* (Nyl.) Zschacke. Spores 2, muriform, brown, $35-50 \times 15-18 \mu$. New to the Canadian Eastern Arctic.
6. *Microgaena sphinctrinoides* (Nyl.) Lönnr.—Clyde Inlet (610). Over mosses and plant remains, scarce. Spores muriform, colorless $33-43 \times 17-20 \mu$. New to the Canadian Eastern Arctic.

DERMATOCARPACEAE

7. *Dermatocarpon hepaticum* (Ach.) Th. Fr.—Clyde Inlet (318); Barnes Ice Cap (867). On soil under overhanging ledges, very common. New to the Canadian Eastern Arctic. The material may include some *D. rufescens* (Ach.) Th. Fr., but the author does not feel inclined to separate out any under that name.

8. *Endocarpon tortuosum* Herre, Bot. Gaz. 51:288. 1911.—General Distribution: Nevada and Montana. Baffin Island: Clyde Inlet (540). On vertical rocks below a gull nest, abundant. This is a most remarkable find of an American species with a peculiar distribution. The plants were examined by Herre, who felt they were close to his species; and the author furthermore compared them with the type of *E. tortuosum* and could find no significant differences. The tortuose nodulate squamules are smaller than those of the type, only 2.5 mm. with less development of stipitate growth, due without doubt to the arctic conditions. There are two spores per ascus, 42-66 x 18-24 μ ; Herre recorded 45-61 x 18-27. The perithecia are identical in size, about 380 μ high and 300 μ wide, immersed, with only a very tiny ostiole visible. The thalloid and hymenial gonidia are also identical. The lower cortex is very characteristic, composed of densely packed vertically arranged cellular hyphae forming a layer 30-50 μ thick in the Baffin specimens and about 60 μ in the type, while the medulla of both is of very loosely woven hyphae. The paraphyses and much of the perithecial contents react dark blue with I, the ascal contents coppery red, although not so distinctly red in the Baffin material.

SPHAEROPHORACEAE

9. *Sphaerophorus fragilis* (L.) Pers.—Pond Inlet (D); Clyde (P); Clyde Inlet (230); Pangnirtung (P); Frobisher Bay (374); Lake Harbour (P). On soil and frequently in sheltered moss hummocks.

10. *Sphaerophorus globosus* (Huds.) Vain.—Pond Inlet (453, P); Clyde (P); Clyde Inlet (231, 232); Barnes Ice Cap (465); Cape Searle (396); Pangnirtung (P); Frobisher Bay (454); Cape Dorset (P). On soil and among mosses in heaths, common. Fertile plants were occasionally found. The iodine test is very useful in separating *S. globosus* (I +) and *S. fragilis* (I —).

EPHEBEACEAE

11. *Ephebe lanata* (L.) Vain.—Clyde Inlet (326). On moist gneiss rocks near a waterfall. Unreported from the Canadian Eastern Arctic.

DIPLOSCHISTACEAE

12. *Diploschistes scruposus* (L.) Norm.—Clyde Inlet (314, 404); Barnes Ice Cap (477). On soil on dry slopes of *Carex* spp., forming large coherent crusts up to 2 dm.; and once on a gneiss bird perch. This conspicuous species had been previously collected in the Canadian Eastern Arctic only on Somerset Island. It is common in other arctic regions and should occur throughout Baffin Island.

GYALECTACEAE

13. *Ionaspis epulotica* (Ach.) Th. Fr.—Clyde Inlet (763, var. *arctica* (Lyng.) H. Magn.). On irrigated gneiss rocks. The height of the hymenium, up to 150 μ , must exclude *I. lavata* H. Magn. New to the Canadian Eastern Arctic.

14. *Ionaspis* cf. *spitsbergensis* H. Magn. Acta Hort. Gothob. 8:34. 1933.—General Distribution: Spitsbergen. Baffin Island: Pond Inlet (786). On irrigated schistose rocks. The plants agree fully with the descriptions and reactions given by Magnusson; unfortunately there was no comparison material for the identification. New to North America.

COLLEMACEAE

15. *Collema ceraniscum* Nyl. Syn. C. *arcticum* Lyng.—Clyde Inlet (871); Lake Harbour (P). Over mosses and plant remains in heaths, rare.

16. *Collema* cf. *glebulentum* (Nyl.) Degel. Syn. C. *furvellum* Räs.—Clyde Inlet (903). On moist open bedrock, common.

17. *Collema tenax* (Sw.) Ach. em. Degel. Syn. C. *pulposum* (Bernh.) Ach.—Clyde Inlet (313, c. fr.). On mosses in wet rock crevices, common. Previously known from Ellesmere. Determined by Degelius.

18. *Leptogium lichenoides* (L.) Zahlbr.—Clyde Inlet (707, var. *pulvinatum* (Hoffm.) Zahlbr.). Over mosses and soil in heaths, common. New to the Canadian Eastern Arctic.

19. *Leptogium saturninum* (Dicks.) Nyl.—Arctic Bay (702); Clyde Inlet (333). Over mosses and on gneiss rocks below bird nests or perches. The plants are very well developed, though always sterile. Confirmed by Degelius. New to the Canadian Eastern Arctic.

20. *Polychidium muscicola* (Sw.) S. Gray.—Clyde Inlet (656, c. fr.). Among mosses and *Cladoniae* in an area of waterfall spray, not common. This is the first record for the Canadian Eastern Arctic. The author decided to place this genus in the Collemaceae instead of the Ephebeaceae in view of the investigations by Dahl (1950) on the fungal anatomy of the species.

PANNARIACEAE

21. *Placynthium asperellum* (Ach.) Trev.—Arctic Bay (P); Pond Inlet (705); Clyde Inlet (322). On calcareous rocks, common.

22. *Pannaria hookeri* (Borr.) Nyl.—Pond Inlet (735); Clyde Inlet (537); Cape Searle (595). On moist gneiss rocks in sheltered areas, common. New to the Canadian Eastern Arctic.

23. *Pannaria isidiata* Degel. Bot. Not. 1943:90. Syn. *Vestergrenopsis isidiata* (Degel.) Dahl (1950, p. 55).—Clyde Inlet (320). On moist gneiss rocks, common and widespread. Apothecia are rare and poorly developed. Determined by Degelius. Unreported from North America and previously known from Scandinavia and Greenland.

24. *Pannaria pezizoides* (Web.) Lightf.—Pond Inlet (644); Clyde Inlet (538); Barnes Ice Cap (652); Cape Searle (397). Over mosses in sheltered habitats, common. This *Pannaria* is also new to the Canadian Eastern Arctic and from the number of finds must be considered common.

25. *Psoroma hypnorum* (Vahl) S. Gray.—Pond Inlet (448, P); Clyde Inlet (539); Barnes Ice Cap (651); Lake Harbour (P). Over mosses in sheltered ravines and on talus slopes.

26. *Parmeliella lepidiata* (Sommerf.) Vain.—Pond Inlet (777); Clyde Inlet (697); Cape Searle (602); Frobisher Bay (558). Over mosses in heaths, widespread. New to the Canadian Eastern Arctic but obviously common.

STICTACEAE

27. *Sticta arctica* Degel.—General Distribution: Alaska and Baffin Island. Baffin Island: Pond Inlet (P); Clyde Inlet (319). Over mosses in a dense *Cassiope* heath, rare. This eastern arctic species, first described from Alaska, must be rare, though widely distributed, in the Canadian Arctic. Determination confirmed by Degelius.

PELTIGERACEAE

SOLORINA Ach.

The *Eusolorinae* have been much overlooked in the Canadian Eastern Arctic. They are perhaps most common in the continental fiord heads but should range to the coasts, at least in the south. The only reliable method of separating the plants is by microscopic examination of the spores, since the arctic conditions so often impress a similar habit on the thalli of the species. *S. crocea* and *S. spongiosa* are circumpolar in distribution; the rest are western species, found from North America east to Novaya Zemlya.

1. Thallus squamulose to crustose, apothecia frequently occurring singly on the squamules.
 2. Thallus passing into a brown crust; spores 4 32. *S. spongiosa*
 2. Thallus distinctly lobed, 3-7 mm. broad; spores 2 28. *S. bispora*
 1. Thallus foliose, irregularly lobed, apothecia usually several on the thallus lobes.
 3. Underside of thallus red-orange 29. *S. crocea*
 3. Underside of thallus brownish or pale.
 4. Spores 8; thallus large, brownish red 30. *S. octospora*
 4. Spores 4; thallus (in arctic) less than 3 cm. broad, pale green to brownish 31. *S. saccata*
 4. Spores 2; thallus less than 2 cm. broad, frequently pruinose at the margin 28. *S. bispora*
28. *Solorina bispora* Nyl.—Pond Inlet (436); Clyde Inlet (259); Cape Searle (514). On soil under or near overhanging ledges, common. This species is new to Baffin Island but has been collected to the south on Akpatok Island. It is probably this species which is so often parasitized by *Pleospora hookeri* (Schaer.) Keissl.

29. *Solorina crocea* (L.) Ach.—Pond Inlet (347); Clyde (P); Clyde Inlet (260); Barnes Ice Cap (473); Cape Searle (428); Pangnirtung (P); Frobisher Bay (445);

Cape Dorset (P). On wet sandy soil or less frequently over mosses, common in exposed areas and in the fellmark.

30. *Solorina octospora* Arn. Pond Inlet (533, sterile); Clyde Inlet (257); Cape Searle (394). On mossy banks near or under overhanging ledges. This species was very abundant at Clyde Inlet. The large appressed lobes with a reddish tinge are very typical; individual thalli are often up to 8 cm. in diameter. Previously recorded from Ellesmere.

31. *Solorina saccata* (L.) Ach.—Arctic Bay (522); Clyde Inlet (261). On mosses and soil in sheltered habitats. One of the rarest *Solorinae* on Baffin Island, easily confused in the field with *S. bispora*, as Lynge found in Greenland.

32. *Solorina spongiosa* (Sm.) Anzi.—Clyde Inlet (492). On mosses in sheltered *Cassiope* heaths, scarce. Thallus minutely squamulose to crustose; spores 4, 35-46 x 16-21 μ . This species is probably more common southward, but it must be relatively less abundant here than in southern Greenland, for example. This is the first record for the Canadian Eastern Arctic.

33. *Nephroma arcticum* (L.) Torss.—Lake Gillian (Dansereau, 5008090793); Pangnirtung (P.) In heaths with *Rhacomitrium lanuginosum*. This conspicuous species must be continental and southern in distribution.

34. *Nephroma expallidum* Nyl.—Arctic Bay (373); Pond Inlet (361); Clyde Inlet (239); Cape Searle (507). In *Carex* meadows and *Cassiope* heaths, common. A conspicuous heath lichen previously unreported from the Canadian Eastern Arctic.

PELTIGERA Willd.

The recent monograph of the North American species of *Peltigera* by Thomson (1950) has been used as a basis for the taxonomy of this group.

1. Upperside of thallus smooth or verruculose-scabrid, lacking tomentum.
 2. Upperside verruculose-scabrid, underside with broad veins39. *P. scabrosa*
 2. Upperside smooth, veins broad or narrow.
 3. Thallus small, 1 (-2) cm. broad, fan shaped, with horizontal apothecia and cephalodia below40. *P. venosa*
 3. Thallus large, more than 1 cm. broad, not fan shaped; with erect apothecia and no cephalodia below.
 4. Thallus broad, with no soredia on the upper surface38. *P. polydactyla*
 4. Thallus pusilloid, with soredia on the upper surface36b. *P. canina* var. *spuria* f. *sorediata*
 1. Upperside of thallus with tomentum, especially toward the margin.
 5. Upper surface with scattered dark cephalodia35. *P. aphthosa*
 5. Upper surface without cephalodia.
 - [6. Upper surface with scattered peltate isidia*P. lepidophora*]
 6. Upper surface without isidia or with peltate isidia.
 7. Tomentum at the margins erect, veins lacking below37. *P. malacea*
 7. Tomentum appressed, with veins below.
 8. Upper surface dull, rhizinae simple or fibrillose36. *P. canina*
 - [8. Upper surface shining, rhizinae penicillate*P. membranacea*]
 35. *Peltigera aphthosa* (L.) Willd. var. *aphthosa*—Qilalukan (T); Pond Inlet (444, D); Clyde Inlet (235); Barnes Ice Cap (462); Cape Searle (509); Pangnirtung (P); Lake Harbour (P). Over mosses and plants on soil in wet heaths or *Carex* marshes, sometimes forming tosettes more than 20 cm. across.
 - 35a. *Peltigera aphthosa* var. *variolora* (Mass.) Thomson. Syn. *P. leucophlebia* (Nyl.) Gyl.—Clyde Inlet (535, f. *complicata* (Th. Fr.) Zahlbr.); Pangnirtung (D, P); Lake Harbour (P). Over mosses on a sheltered stream bank. Polunin's specimens were determined by Lynge as *P. leucophlebia*, but Thomson has called them var. *variolora*, the former plant originally described as having pale or white veins, the latter having dark distinct veins.
 36. *Peltigera canina* (L.) Willd.—Pangnirtung (D, var. *albescens* (Wahlb.) Thomson).
 - 36a. *Peltigera canina* var. *rufescens* (Weis) Mudd. Syn. *P. rufescens* Humb.—Arctic Bay (530); Pond Inlet (363); Clyde Inlet (264); Barnes Ice Cap (497); Frobisher Bay (446). On soil and over mosses in sheltered areas, common. Previously collected from Repulse Bay and Ellesmere in the Eastern Arctic.
 - 36b. *Peltigera canina* var. *spuria* f. *sorediata* Schaer. Syn. *P. erumpens* (Tayl.) Vain. *P. leptoderma* Nyl. *P. erumpens* f. *leptoderma* (Nyl.) Schol.—Clyde (P); Clyde Inlet (536); Barnes Ice Cap (461). On soil and over mosses on moist sheltered banks.

The *P. canina* group is extremely plastic and continued experimental studies are proving the invalidity of "species" which are merely growth or regeneration forms. The forms retained here as subspecific entities are often regarded as species.

37. *Peltigera malacea* (Ach.) Funck.—Clyde Inlet (233). Over mosses in sheltered places, not common.

38. *Peltigera polydactyla* (Neck.) Hoffm.—Pond Inlet (443); Clyde Inlet (278). Over mosses in sheltered heaths, scattered. Unreported from the Canadian Eastern Arctic. The specimens at Clyde Inlet were well developed, growing with *P. malacea* and *P. scabrosa*.

39. *Peltigera scabrosa* Th. Fr.—Clyde (D, P); Clyde Inlet (277); Barnes Ice Cap (629); Pangnirtung (P). Over mosses and heath plants, widespread.

40. *Peltigera venosa* (L.) Baumg.—Pond Inlet (359); Clyde Inlet (258); Cape Searle (425). On wet sandy soil in *Carex* bogs or under overhanging rocks and ledges, common. Evidently a widespread species which has been overlooked.

Peltigera lepidophora (Nyl.) Vain. is known from many parts of Greenland and was collected by Thomson at Churchill (unpublished). It should occur on southernmost Baffin Island. Otherwise it is rare in North America. *Peltigera membranacea* (Ach.) Nyl. is reported by Lynge from northern Quebec and without doubt occurs on southern Baffin Island. It is, however, increasingly rarer from the Pacific coast eastward to the eastern arctic. *Peltigera scutata* (Dicks.) Duby, reported from the literature at Kikerton by Lynge, can probably be excluded from the flora of Baffin Island in view of the North American distribution given by Thomson, where it is shown confined to the Pacific coast region. Dahl (1950), however, reports it from southwest Greenland. This type of distribution, which is known for several species of plants, is additional evidence of the Scandinavian element in Greenland's lichen flora.

LECIDEACEAE

LECIDEA (Ach.) Th. Fr.

The following 34 species of this large genus are hardly to be considered even half of the total number occurring in the region, but a number of unidentified specimens yet remain in the author's collection. No key will be constructed for these species since its scope and usefulness would be far too limited. Excellent keys to most of the *Lecideae* on Baffin Island are easily accessible in Lynge (1937, 1940); there are also valuable ones in Lowe (1939), Magnusson (1936), and Vainio (1934).

41. *Lecidea aena* Duf.—Eclipse Sound (*T. var. canadensis* Lynge).

42. *Lecidea arctogena* Th. Fr.—General Distribution: Canadian Eastern Arctic east to Scandinavia. Baffin Island: Barnes Ice Cap (727). On schistose rocks, well developed locally. A good example of a rare species found in an unstable habitat.

43. *Lecidea atrobrunnea* (Ram.) Schaer.—Arctic Bay (P); Cape Searle (672). On phonolite at the bird cliffs, common.

44. *Lecidea auriculata* Th. Fr.—Clyde Inlet (853). On gneiss rocks. New to the Canadian Eastern Arctic but known from a number of localities in the United States.

45. *Lecidea baffiniana* H. Magn. (1952, p. 43).—Cape Searle (391). On basalt at the bird cliffs. This species is very close to *L. plana*.

46. *Lecidea berengeriana* (Mass.) Th. Fr.—Clyde Inlet (857). On soil and mosses in sheltered habitats.

47. *Lecidea confluens* (Wigg.) Ach.—Clyde (P).

48. *Lecidea cuprea* Sommerf.—Clyde Inlet (674). Over mosses and soil on talus boulders, common and widespread. Thallus P + orange-red. Apparently new to North America.

49. *Lecidea cyanescens* Lynge (1937, p. 63).—Cape Searle (197). On schist. Thallus white, I +, P + yellow, exciple K + red. New to North America, known previously from the type locality in west Greenland.

50. *Lecidea decipiens* (Ehrh.) Ach.—Clyde Inlet (312); Cape Searle (398). On irrigated soil and marble at Clyde Inlet; on soil at the bird cliffs; common. This calciphilous species has been known in the Canadian Eastern Arctic only from Ellesmere.

51. *Lecidea demissa* (Rutstr.) Ach.—Clyde Inlet (690); Barnes Ice Cap (654); Cape Searle (605); Frobisher Bay (661). On moist soil near sheltered erratics and gneiss outcrops. A very common species unreported from the Canadian Eastern Arctic.

52. *Lecidea dicksonii* Ach.—Arctic Bay (795, P); Pond Inlet (546); Clyde Inlet (327); Barnes Ice Cap (549); Cape Dorset (P). On exposed rocks, commonly ferruginous schists, common.
53. *Lecidea elata* Schaer.—Arctic Bay (P); Clyde Inlet (696, var. *subfarinosa* H. Magn. f. *planula* H. Magn.). On sheltered gneiss rocks, common and well developed. Specimens from Clyde Inlet determined by Magnusson.
54. *Lecidea ementiensis* Nyl.—Pond Inlet (P).
55. *Lecidea flavocaulescens* (Hornem.) Ach.—Pangnirtung (P); Lake Harbour (P).
56. *Lecidea glomerulosa* (DC.) Steud.—Clyde Inlet (866). On caribou antlers. New to the Canadian Eastern Arctic.
57. *Lecidea homosema* Nyl. Lich. Pyren. Orient. 46. 1891.—*General Distribution*: the Pyrenees and Torne Lappmark (Sweden). *Baffin Island*: Cape Searle (732). On phonolite at the bird cliffs. A new record for North America, determined by Magnusson, who recently found it in Torne Lappmark. The author's collection is the second one outside of the type locality.
58. *Lecidea lapicida* Ach.—Arctic Bay (599, P); Clyde Inlet (671); Barnes Ice Cap (564); Lake Harbour (P). On gneiss rocks, very common as f. *ecrustacea* Anzi.
59. *Lecidea lulensis* (Hellb.) Th. Fr.—Arctic Bay (P); Clyde Inlet (864). On gneiss rocks near the bird nests, rare.
60. *Lecidea melinodes* (Kbr.) H. Magn.—*General Distribution*: Canadian Arctic to Spitsbergen. *Baffin Island*: Pond Inlet (566); Clyde Inlet (580); Barnes Ice Cap (561); Pangnirtung (P). On gneiss rocks, often irrigated.
61. *Lecidea obnubila* Th. Fr. & Hellb.—Pangnirtung (P).
62. *Lecidea pantherina* Ach.—Arctic Bay (P); Clyde Inlet (698); Barnes Ice Cap (562); Cape Searle (619). On gneiss and schists, usually in sheltered habitats.
63. *Lecidea pelybotryon* (Wahlb.) Leight.—Pond Inlet (569); Clyde Inlet (695); Frobisher Bay (543). On moist sheltered gneiss outcrops. All plants, excepting those from Clyde Inlet, were sterile, thallus Ca + red. Some of the material then may be *L. panaeola* Ach. New to the Canadian Eastern Arctic but undoubtedly widespread.
64. *Lecidea pungens* (Kbr.) Nyl.—Mitimatalik (T).
65. *Lecidea ramulosa* Th. Fr.—Pond Inlet (D); Clyde Inlet (442, 726). Over matted *Carex* spp. in wet habitats, common. The plants from Clyde Inlet are fully typical, with numerous apothecia up to 2 mm. in diameter.
66. *Lecidea rubiformis* Wahlb.—Arctic Bay (449); Pond Inlet (351); Clyde Inlet (324); Cape Searle (399); Frobisher Bay (364). On soil, frequently in sheltered crevices near rocks. It is incredible that such a conspicuous and widespread species as this should have been overlooked by previous collectors. The only other report from the area is Ellesmere. It was observed nearly every day at Clyde Inlet, growing typically on soil at the bases of erratics, on overhanging soil ledges, or in cracks between rocks.
67. *Lecidea soredizodes* (Nyl.) Vain.—Arctic Bay (P); Barnes Ice Cap (560). On sheltered gneiss boulders.
68. *Lecidea speirea* Ach.—Lake Harbour (P).
69. *Lecidea steriza* (Ach.) Vain. Syn. *L. macrocarpa* (DC.) Th. Fr.—Clyde (P).
70. *Lecidea tessalata* Flk.—Arctic Bay (P); Clyde Inlet (863); Pangnirtung (P). On gneiss rocks in a dried up streambed, common.
71. *Lecidea vernalis* (L.) Ach.—Clyde Inlet (700). Over mosses in sheltered areas, common. Previously unreported from Baffin Island where it should be a common species.
72. *Lecidea vorticosa* (Flk.) Kbr.—Clyde Inlet (856). On gneiss pebbles, rare. An inconspicuous species previously known from Ellesmere.
73. *Lecidea wulfenii* (Hepp) Arn.—Clyde Inlet (865); Lake Harbour (P). Over mosses in a *Carex* meadow.
74. *Bacidia muscorum* (Sw.) Mudd.—Clyde Inlet (680). Over mosses on sandy soil, scarce but widespread. New to the Canadian Eastern Arctic.
75. *Toninia caeurulonigricans* (Lightf.) Th. Fr.—Clyde Inlet (583). With mosses on soil over marble, common.
76. *Toninia candida* (Web.) Th. Fr.—Clyde Inlet (706). Over marble and soil at marble outcrops, common.
77. *Toninia lobulata* (Sommerf.) Lynge.—Pond Inlet (868); Clyde Inlet (585) Cape Searle (613). Over mosses and soil, common. Spores mostly 3 septate.

78. *Lopadium fuscoluteum* (Hoffm.) Mudd—Clyde Inlet (584). Over mosses and soil on talus boulders, common but scattered.

79. *Lopadium muscicolum* (Sommerf.) Kbr.—Pond Inlet (P); Clyde (P); Clyde Inlet (582); Cape Searle (621). Over mosses in ravines and moist habitats, common.

RHIZOCARPON (Ram.) Th. Fr.

The main basis for separating species in this genus, spore septation and color, necessitates microscopic examination of all plants. The following key is adapted in part from Lynge's (1932a) excellent monograph of the genus in Greenland.

1. Thallus distinctly yellow.
 2. Spores muriform; thallus I + blue 86. *R. geographicum*
 2. Spores 1 septate; thallus I —.
 3. Thallus KOH + blood red 81. *R. chionophilum*
 3. Thallus KOH — 89. *R. occidentale*
1. Thallus white, gray to brown with no distinct yellow color.
 4. Spores muriform.
 5. Thallus white subcontinuous 90. *R. petraeum*
 5. Thallus dark, gray to brown.
 6. Ascus with 8 spores; thallus I + blue.
 7. Thallus KOH —, with a brownish cast 87. *R. grande*
 7. Thallus KOH + yellow to red, not brownish 84. *R. eupetraeum*
 6. Ascus with 2 spores; thallus I — 83. *R. disporum*
 4. Spores 1 septate.
 8. Spores dark brown at maturity.
 9. Medulla KOH + red 82. *R. copelandii*
 9. Medulla KOH —.
 10. Hymenium violet with KOH in the upper part.
 11. Thallus brown, continuous and areolate without a conspicuous hypothallus 80. *R. badioatrum*
 11. Thallus reddish brown, discontinuous with peltate squamulose areolae; black hypothallus conspicuous 91. *R. rittokense*
 10. Upper part of hymenium KOH + green 88. *R. jemtlandicum*
 8. Spores at maturity colorless 85. *R. expallescens*

80. *Rhizocarpon badioatrum* (Flk.) Th. Fr.—General Distribution: Canadian Eastern Arctic to Novaya Zemlya. Baffin Island: Clyde Inlet (691); Cape Searle (607); Pangnirtung (P); Lake Harbour (P). On gneiss rocks, often near stream, common.

81. *Rhizocarpon chionophilum* Th. Fr.—General Distribution: Canadian Eastern Arctic to Novaya Zemlya. Baffin Island: Arctic Bay (P); Clyde (P); Clyde Inlet (590); Frobisher Bay (576). On gneiss rocks, common at high elevations (1000 m.).

82. *Rhizocarpon copelandii* (Kbr.) Th. Fr.—Mitimatalik (T); Clyde Inlet (731); Barnes Ice Cap (745). On gneiss rocks, usually in moist habitats.

83. *Rhizocarpon disporum* (Naeg.) Mull. Arg.—Arctic Bay (P); Mitimatalik (T); Clyde Inlet (609); Cape Searle (596); Lake Harbour (P). On gneiss rocks in all situations, rare at Clyde Inlet.

84. *Rhizocarpon eupetraeum* (Nyl.) Arn.—Lake Harbour (P).

85. *Rhizocarpon expallescens* Th. Fr. Lich. Scand. 620. 1874.—Barnes Ice Cap (728). On schistose rocks, abundant. Lynge (1937) suggested that this species is circumpolar; its discovery from Baffin Island, a new record for North America, now fills the gap. The specimens agree perfectly with Malme, Lich. succ. exs. 475.

86. *Rhizocarpon geographicum* (L.) DC.—Arctic Bay (600, P); Mitimatalik (T); Pond Inlet (545); Clyde (P); Clyde Inlet (870); Barnes Ice Cap (567); Cape Searle (608); Pangnirtung (P); Frobisher Bay (541); Lake Harbour (P); Cape Dorset (P). On gneiss rocks in all situations. This is the commonest and most conspicuous *Rhizocarpon*, often associated with *R. disporum* or *R. grande*. It can be easily confused with *R. chionophilum* in the field, although that species usually has a distinct greenish tinge; or with *R. occidentale*, which, however, is I —.

87. *Rhizocarpon grande* (Flk.) Arn.—Clyde Inlet (590). On gneiss rocks, common.

88. *Rhizocarpon jemtlandicum* Malme.—General Distribution: eastern Canada to Novaya Zemlya. Baffin Island: Mitimatalik (T); Clyde (P); Clyde Inlet (553); Cape

Searle (626); Pangnirtung (P); Frobisher Bay (736); Lake Harbour (P); Cape Dorset (P). On gneiss rocks everywhere.

89. *Rhizocarpon occidentale* Lyng. (1932a, p. 20)—*General Distribution*: Colorado, Greenland, Iceland, and Spitsbergen. *Baffin Island*: Clyde Inlet (719); Cape Searle (587). On gneiss rocks; on phonolite at the bird cliffs. Thallus KOH —, I —, agreeing in all respects with Lyng's descriptions. Whether it is distinct from *R. crystalligenum* Lyng (KOH +) and *R. superficiale* (Schaer.) Malme (I +), could be questioned. The chemical segregates of this group should offer a good opportunity for a critical population study.

90. *Rhizocarpon petraeum* (Wulf.) Mass. *sensu* Malme (1914)—Clyde Inlet (900); Barnes Ice Cap (901). On moist gneiss rocks, especially abundant at the Ice Cap. Thallus white to grayish white, subcontinuous; apothecia immersed to adnate with a \pm persistent margin. Hymenium up to 200 μ ; spores muriform, mostly colorless, 25-39 x 8-14 μ . These observations correspond quite well with the European concept of this species. It is impossible to state its range in North America, because the *R. petraeum* group has been badly confused.

91. *Rhizocarpon riitokense* (Hellb.) Th. Fr.—*General Distribution*: eastern Canada to Novaya Zemlya. *Baffin Island*: Clyde Inlet (689); Pangnirtung (P); Frobisher Bay (542). On gneiss erratics, common. This species is also common in west Greenland but only of scattered occurrence eastward.

STEREOCAULACEAE

The nomenclature in this family is after Lamb (1951), who identified all the specimens and gave some valuable suggestions for constructing the key. During his investigations on *Stereocaulon*, Lamb concluded that the lichen body here is actually a primary structure, and for this reason he removed the genus from the Cladoniaceae and placed it in a new family, the Stereocaulaceae, with the closest affinity with the Lecideaceae, especially the genus *Toninia*.

1. Phyllocladia white to greyish-white with a slightly depressed olivaceous center 99. *S. vesuvianum*
1. Phyllocladia uniformly white to greyish-white.
2. Phyllocladia sorediate.
3. Soredia distinctly capitate; pseudopodetia rarely branched 95. *S. leprocephalum*
3. Soredia diffuse, farinose; pseudopodetia richly branched 93. *S. capitellatum*
2. Phyllocladia esorediose.
4. Plants growing firmly attached to stones 92. *S. botryosum*
4. Plants growing on soil or among higher plants and mosses.
5. Tomentum thin, appressed; cephalodia conspicuous, up to 1.5 mm., subglobose, smoothly corticate 94. *S. glareosum*
5. Tomentum thick, loose; cephalodia minute, verrucose.
6. Phyllocladia P + orange to orange-red. Apothecia mostly lateral 98. *S. tomentosum*
6. Phyllocladia P + yellow or P —. Apothecia terminal.
7. Pseudopodetia often attached to the substratum; usually fragile; apothecia plane, large 97. *S. rivulorum*
7. Pseudopodetia growing free of the substratum usually and dying away at the base; apothecia rare, small 96. *S. paschale*
92. *Stereocaulon botryosum* Ach.—Clyde Inlet (733); Frobisher Bay (663). On gneiss rocks, not common but widespread. Both collections belong to Chemical Strain I (atrorinine and lobaric acid).
93. *Stereocaulon capitellatum* H. Magn. Göteborgs Kungl. Vet. och Vitter. Samh. Handl. 30:39. 1926.—*General Distribution*: Scandinavia. *Baffin Island*: Clyde Inlet (229). On moist gneiss rocks near a water fall. The specimens, according to Lamb (*in litt.*), are considerably larger than the type material and seem to represent the species in its optimal development, the type being somewhat meagerly developed. This is a new record for North America.

94. *Stereocaulon glareosum* (Sav.) H. Magn. var. *corymbosulans* M. Lamb, n. var.

"Diagn.: A forma typica speciei in eo recedit, quod apothecia mox capituliformiter in discos secundarios numerosos convexosque proliferunt, pseudopodetiis tunc infra apothecia minute corymbosula-divisis.

"Typus: U. S. S. R., Mongolia, Kreis Usinsk, Bolschejskoe Lake, coll. B. Schischkin, 1908 (no. 29), in herb. A. H. Magnusson.

"In the type specimen the pseudopodetia are upright, loosely caespitose, firmly attached to the substratum at the base, 2.5-3.5 cm. high, sparingly \pm dichotomously branched, but with the main axis distinct to the summits; (0.5-) 0.8-1.0 (-1.2) mm. thick, terete, fairly strong and rigid, becoming almost ligneous towards the base, in most places covered with a thin, close, smooth, spongy-felted, ochraceous-grayish tomentum, in other places denuded and smoothly glabrous. Phyllocladia present at all levels on the pseudopodetia, but scattered, not very numerous, often congregated in clusters; distinctly elongate-papillate, up to about 0.8 mm. long, simple or branched, evenly distributed on all sides of the pseudopodetium. Cephalodia fairly numerous, conspicuous, laterally sessile on pseudopodetia at different levels, subglobose, constricted at the base, with smoothly rounded or slightly indented or cracked, matt surface, aeruginose-grayish to pale ochraceous, 0.3-0.9 mm. diam., containing *Nostoc*. Apothecia numerous, terminal, soon furrowed and lobate and dividing into composite heads 2-4 mm. diam. of clustered convolvinate, secondary apothecia, 0.5-1.2 mm. diam., immarginate from the first; the pseudopodetia dividing into a number of fine corymbose branchlets immediately below its point of insertion into the apothecial heads. Phyllocladia PD + (slowly) faint sulphur-yellowish or —. Thecium 50-60 μ high. Spores 1-3 septate, straight, 24-34 x 3.0-3.5 μ .

"Dr. Hale's specimen from Baffin Island (no. 273) agrees well with the above type specimen in its general habitus and in the corymbose development of secondary apothecia, but differs somewhat in having the pseudopodetia largely denuded and glabrous, the typical smooth closely felted tomentum being visible in only a few places; also in the phyllocladia being all clustered-granuliform, not growing out into distinct papillate shape. The cephalodia are quite typical, up to 1.5 mm. diam., ochraceous-roseate, with *Nostoc*. Phyllocladia PD + (slowly) sulphur-yellow. I have also seen a specimen of this variety from Alaska, Lake Peters, lat. 69°20', long. 145°, collected in 1948 by P. F. Scholander and W. Flagg, in the Smithsonian Institution herbarium."

On soil near permanent snowdrifts, glaciers and exposed out-wash. New to the Canadian Eastern Arctic.

95. *Stereocaulon leprocephalum* Vain. Arkiv Bot. 8:35. 1909.—Clyde Inlet (289, c. fr.). On soil among tightly packed mosses, rare but abundant where found. This distinctive species had been previously known from the type locality in Pitkeai, Siberia. The present collection contains fertile plants, hitherto unknown. The apothecial characters indicate the affinity of the species with the *vesuvianum* group.

96. *Stereocaulon paschale* (L.) Hoffm. var. *paschale*.—Pangnirtung (P); Lake Harbour (P).

96a. *Stereocaulon paschale* var. *alpinum* (Laur.) Mudd. Syn. *S. alpinum* Laur.—Arctic Bay (P); Mitimatalik (T); Pond Inlet (643, P); Clyde (P); Clyde Inlet (227); Barnes Ice Cap (483); Totnes Road (S); Pangnirtung (D, P); Lake Harbour (P); Cape Dorset (P). On soil and among mosses in *Cassiope* heaths and *Carex* meadows. Lamb considers var. *alpinum* merely an ecotype of the species.

97. *Stereocaulon rivulorum* H. Magn.—General Distribution: Canadian Eastern Arctic to Scandinavia. Baffin Island: Clyde (P); Barnes Ice Cap (494, c. fr.); Cape Searle (734); Pangnirtung (P). On wet sandy soil near the Ice Cap, forming hemispherical balls, very common; in heaths at Cape Searle. Distinguishing between sterile *S. rivulorum* and *S. paschale* is very difficult indeed; the key characters are useful suggestions only and often break down. Certain determination is possible with fertile plants.

98. *Stereocaulon tomentosum* Fr.—Clyde Inlet (226, var. *alpestre* Flot.). On soil and mosses on a talus boulder, rare. Reported only a few times from Baffin Island where it seems southern and continental.

99. *Stereocaulon vesuvianum* Pers. Syn. *S. denudatum* Flk.—Var. *denudatum* (Flk.) M. Lamb: Clyde (P); Pangnirtung (P); Cape Dorset (P).

99a. *Stereocaulon vesuvianum* var. *arcticum* (Lyng.) M. Lamb. Syn. *S. arcticum* Lyng.—Clyde Inlet (228, 274); Cape Searle (432); Frobisher Bay (662); Lake Harbour (P). On soil and among mosses in heaths.

99b. *Stereocaulon vesuvianum* var. *glaucescens* (Tuck.) M. Lamb.—Clyde Inlet (262). On sand in exposed outwash plains, forming large colonies of discrete hemispherical plants about 6 cm. in diameter, very abundant. Previously known as far north as New Hampshire.

CLADONIACEAE

100. *Baeomyces placophyllus* Ach.—General Distribution: eastern North America to Scandinavia. Baffin Island: Clyde Inlet (556). On soil over sheltered talus boulders, common and wide-spread. The first collection of the species in the Canadian Eastern Arctic. The plants are fully typical, attaining a diameter of 6 cm. with distinct marginal lobes; thallus P + red-orange.

CLADONIA Hill

Nearly all of the specimens in this genus have been examined by A. W. Evans, who gave the author information on the nomenclature and distribution of some of the species and helpful comments on the preparation of the key. In the genus *Cladonia* the microchemical methods (Dahl, 1950; Evans, 1943) are very useful in separating certain species. A list of all the acids known to occur in the Baffin Island *Cladoniae* is given in table 2.

1. Primary thallus crustaceous, rarely seen; podetia in many cases more or less intricately branched, dying away at the base, without squamules or soredia.
2. Podetia forming regular discrete colonies, the upper part of rounded, compact thryoid clusters of branches. P — 101. *C. alpestris*

TABLE 2.—Lichen acids found in species of *Cladonia* from Baffin Island.

| | atrorhine | barbatic acid | bellidiflorine | fumarprotocetic acid | psoromic acid | squamatic acid | usnic acid | zeorine |
|-----------------------------|-----------|---------------|----------------|----------------------|---------------|----------------|------------|---------|
| <i>Cladonia alpestris</i> | — | — | — | — | — | — | + | — |
| <i>C. alpicola</i> | — | — | — | — | + | — | — | — |
| <i>C. amaurocraea</i> .. | — | + | — | — | — | — | + | — |
| <i>C. bellidiflora</i> | — | — | + | — | — | + | — | — |
| <i>C. cariosa</i> | + | — | — | — | — | — | — | — |
| <i>C. chlorophaea</i> .. | — | — | — | + | — | — | — | — |
| <i>C. coccifera</i> | — | + | — | — | — | — | + | — |
| <i>C. cornuta</i> | — | — | — | + | — | — | — | — |
| <i>C. cyanipes</i> | — | + | — | — | — | — | + | — |
| <i>C. degenerans</i> | — | — | — | + | — | — | — | — |
| <i>C. elongata</i> | — | — | — | + | — | — | — | — |
| <i>C. farinacea</i> | — | — | — | + | — | — | — | — |
| <i>C. fimbriata</i> | — | — | — | + | — | — | — | — |
| <i>C. gonecha</i> | — | — | — | — | — | + | + | — |
| <i>C. gracilis</i> | — | — | — | + | — | — | — | — |
| <i>C. lepidota</i> | + | — | — | + | — | — | — | — |
| <i>C. macrophyllodes</i> | + | — | — | + | — | — | — | — |
| <i>C. mitis</i> | — | — | — | — | — | — | + | — |
| <i>C. pleurota</i> | — | — | — | — | — | — | + | + |
| <i>C. pyxidata</i> | + | — | — | + | — | — | — | — |
| <i>C. rangiferina</i> | + | — | — | + | — | — | — | — |
| <i>C. squamosa</i> | — | — | — | — | — | + | — | — |
| <i>C. subcervicornis</i> | + | — | — | + | — | — | — | — |
| <i>C. sylvatica</i> | — | — | — | + | — | — | + | — |
| <i>C. uncialis</i> | — | — | — | — | — | + | + | — |

2. Podetia forming irregularly branched entangled and unlimited colonies.
3. Podetia intricately branched, the peripheral branches in groups of 2-4; true cortex lacking.
4. Podetia gray to grayish-brown. P +, KOH + 121. *C. rangiferina*

4. Podetia yellow to white. KOH —.
5. Peripheral branches more or less curved in one direction. P + 124. *C. sylvatica*
5. Peripheral branches extending in various directions. P — 118. *C. mitis*
3. Podetia simple or only several times branched; corticate.
6. Podetia frequently cup forming with few, if any, side branches. Barbatic acid present 103. *C. amaroeracea*
6. Podetia not cup forming; several times branched. Barbatic acid absent 125. *C. uncialis*
1. Primary thallus well developed, rarely evanescent; podetia simple or rarely branched, frequently cup forming, with squamules or soredia or both.
7. Podetia distinctly yellow. Usnic acid present.
8. Podetia narrow, without cups or with imperfect cups.
9. Podetia densely squamulose, esorediate, with large basal squamules; apothecia red 104. *C. bellidiflora*
9. Podetia not squamulose, with farinose soredia and small basal squamules; apothecia pale brown 109. *C. cyanipes*
8. Podetia stout, with more or less well developed cups.
10. Podetia esorediose, with scattered areolae 107. *C. coccifera*
10. Podetia sorediose, largely ecorticate.
11. Cups shallow; podetia often lacerate, 3-4 cm. high with farinose soredia 114. *C. gonecha*
11. Cups deep, goblet shaped; podetia entire, rarely more than 2 cm. high, with granular soredia 119. *C. pleurota*
7. Podetia gray to greenish gray. Usnic acid absent.
12. Podetia cup forming, stout; basal squamules well developed.
13. Cups without proliferations.
14. Podetia sorediose.
15. Cups shallow, with farinose soredia 113. *C. fimbriata*
15. Cups deep, granular soredia 106. *C. chlorophaea*
14. Podetia esorediose, often with scattered areolae above.
16. Primary squamules well developed, widely spreading and parallel to the substratum 120a. *C. pyxidata* var. *poillum*
16. Primary squamules not widely spreading, usually erect 120b. *C. pyxidata* var. *neglecta*
13. Cups with proliferations.
17. Cups with central and marginal proliferations; axils closed.
18. Basal squamules large and elongate, white beneath; podetia often absent.
19. Squamules chalky white on entire under surface 117. *C. macrophyllodes*
19. Squamules white but becoming more or less gray toward the base 123. *C. subcervicornis*
18. Basal squamules small, not white beneath; podetia well developed 116. *C. lepidota* f. *gracilescens*
17. Cups with marginal proliferations.
20. Podetia with a well developed cortex. P + 110. *C. degenerans*
20. Podetia ecorticate, squamulose. P — 122. *C. squamosa*
12. Podetia acuminate and narrow, with no cups or very narrow cups at the tips; basal squamules frequently evanescent.
21. Podetia branched several times, with open axils.
22. Cortex well developed with some soredial patches near tips of podetia. P + 122. *C. farinacea*
22. Cortex lacking, esorediose; often densely squamulose. P — 122. *C. squamosa*
21. Podetia unbranched, or if branched, with closed axils.
23. Podetia with patches of soredia 108. *C. cornuta*
23. Podetia esorediose.
24. Cortex subcontinuous or of dispersed areolae; podetia stout.
25. Podetia short, less than 1.5 cm. high. KOH +, atronrine present 105. *C. cariosa*
25. Podetia usually more than 2 cm. high. KOH —, atronrine

- absent 102. *C. alpicola*
 24. Cortex continuous; podetia elongate and acuminate with or without narrow cups.
 26. KOH + yellow, atronorine present.
 27. Base of podetia with scattered pale areolae on a black medulla, presenting a mottled appearance 116. *C. lepidota* f. *stricta*
 27. Base of podetia continuous, not mottled 111. *C. elongata*
 26. KOH —, atronorine absent 115. *C. gracilis*
 101. *Cladonia alpestris* (L.) Rabh.—Pond Inlet (451); Clyde Inlet (246); Lake Harbour (D, P). Among mosses in sheltered *Cassiope* heaths or on hummocks in *Carex* marshes, rare. The typical northern form, usually with rather narrow thrysoid heads, is 5-8 cm. high with very coarse branches which are frequently split from the tips to the gaping axils.
 102. *Cladonia alpicola* (Flot.) Vain.—Clyde Inlet (288, 299); Barnes Ice Cap (631); Pangnirtung (D, P); Lake Harbour (P). On soil or over compacted mosses on talus slopes, or on soil on dry open hillsides, common; usually sterile.
 103. *Cladonia amaurocrea* (Flk.) Schaer.—Pond Inlet (357, P); Clyde Inlet (243); Barnes Ice Cap (655); Pangnirtung (P); Frobisher Bay (588). Among mosses in heaths, common. At Clyde Inlet a tuft 30 cm. in diameter and more than 20 cm. high was found in an area of water fall spray. Cup formation is frequently imperfect and galls are present on many podetia.
 104. *Cladonia bellidiflora* (Ach.) Schaer.—Pond Inlet (387); Clyde (P); Clyde Inlet (244, f. *subuliformis* Vain.); Frobisher Bay (440); Lake Harbour (P); Cape Dorset (D, P). Among mosses in heaths and on hummocks in *Carex* marshes. Plants with apothecia were rare.
 105. *Cladonia cariosa* (Ach.) Spreng.—Clyde Inlet (281). On soil between large talus boulders, not common but widespread. The plants are small, less than 1 cm. high, but fertile.
 106. *Cladonia chlorophaea* (Flk.) Spreng.—Pond Inlet (P); Lake Harbour (P); Cape Dorset (P). Earlier authors have retained this species as a variety of *C. pyxidata*. It is actually well differentiated from that species by the presence of soredia and characteristic acids. The chemistry of the *C. chlorophaea* group, however, is still incompletely known. Dahl (1950) discovered 3 different acids in his Greenland material of *C. *chlorophaea*: grayanic, merochlorophaeic, and the unknown novochlorophaeic. The accessory substance fumarprotocetraric acid was also found in addition to usnic acid in a few specimens.
 107. *Cladonia coccifera* (L.) Willd.—Pond Inlet (298, B); Clyde (P); Clyde Inlet (265, 304); Barnes Ice Cap (498); Pangnirtung (P); Lake Harbour (P); Cape Dorset (P). On soil with mosses in a talus slope.
 108. *Cladonia cornuta* (L.) Schaer.—General Distribution: western North America east to Scandinavia. Baffin Island: Clyde (697, P); Clyde Inlet (701, f. *scyphosa* Schaer.); Cape Searle (620); Frobisher Bay (730). On soil and compacted mosses. These plants are badly weathered and stunted, bearing little resemblance to the magnificent specimens seen farther south.
 109. *Cladonia cyanipes* (Sommerf.) Vain.—Clyde Inlet (305; 285, f. *connectens* Vain.); Pangnirtung (P); Lake Harbour (P). On moss hummocks in *Carex-Sphagnum* bogs, common.
 110. *Cladonia degenerans* (Flk.) Spreng.—Pangnirtung (D).
 111. *Cladonia elongata* (Jacq.) Hoffm.—Arctic Bay (P); Clyde (P); Totnes Road (S); Pangnirtung (P); Lake Harbour (P). Unfortunately the author did not find this problematic species, which is characterized by atronorine and has podetia coarser than in typical *C. gracilis* var. *chordalis*. Plants of this type have been referred to *C. cernocyna* (Ach.) Nyl. by Dahl.
 112. *Cladonia farinacea* Evans. Rhodora 52:95. 1950.—Mitimatalik (T, sub. nom. *C. scabriuscula* f. *farinacea*).
 113. *Cladonia fimbriata* (L.) Fr.—General Distribution: Behring Straits east to Scandinavia. Baffin Island: Cape Searle (637). Among mosses in a *Carex* marsh. This collection repeats one made at the same station in 1867. It is not a common species, at least northward.
 114. *Cladonia gonecha* Asahina.—Pond Inlet (B); Clyde (P); Clyde Inlet (242); Barnes Ice Cap (628); Cape Searle (511); Pangnirtung (P); Frobisher Bay (592);

Lake Harbour (P). On humus and moss hummocks in *Carex-Sphagnum* bogs, common.

115. *Cladonia gracilis* (L.) Willd. var. *chordalis* (Flk.) Schaer.—Clyde Inlet (800); Pangnirtung (D). Among mosses in heaths, apparently rare.

116. *Cladonia lepidota* Nyl.—Pond Inlet (517, D); Clyde (P); Clyde Inlet (302, f. *stricta*; 245, 287, 293, 301; 290, f. *gracilescens*); Cape Searle (586); Totnes Road (S); Pangnirtung (P); Frobisher Bay (516); Cape Dorset (P). On soil and among mosses, very common. At Clyde Inlet *C. lepidota* was one of the most abundant lichens. *F. stricta* occurred among mosses in heaths, frequently in standing water for part of the summer. *F. gracilescens* was most common on soil near rock falls and even in exposed fellmark.

117. *Cladonia macrophyllodes* Nyl.—General Distribution: eastern Canada to Scandinavia. Baffin Island: Lake Harbour (P).

118. *Cladonia mitis* Sandst.—Albert Harbour (T); Mitimatalik (T); Pond Inlet (531, P); Clyde (D, P); Clyde Inlet (280, 300); Barnes Ice Cap (476); Cape Searle (429); Totnes Road (S); Pangnirtung (D, P); Frobisher Bay (358); Lake Harbour (D, P); Cape Dorset (D, P). On soil and among heath plants, very common.

119. *Cladonia pleurota* (Flk.) Schaer.—Clyde Inlet (294); Lake Harbour (P). On soil over talus boulders. The specimens have good development of soredia and contain zeorine.

120. *Cladonia pyxidata* (L.) Hoffm. var. *neglecta* (Flk.) Mass.—Arctic Bay (P); Clyde Inlet (266, 291); Barnes Ice Cap (490); Cape Searle (513); Lake Harbour (P). On soil and over mosses, common in moist habitats.

120a. *Cladonia pyxidata* var. *pocillum* (Ach.) Flot.—Pond Inlet (447); Clyde (P); Clyde Inlet (303); Cape Searle (502); Frobisher Bay (441); Lake Harbour (P); Cape Dorset (P). Over moist compacted mosses in sheltered areas.

121. *Cladonia rangiferina* (L.) Web.—Mitimatalik (T); Pond Inlet (B); Clyde (P); Clyde Inlet (296); Pangnirtung (P); Frobisher Bay (589); Lake Harbour (P). On soil among mosses and heath plants. At the northern stations *C. rangiferina* is rare, although well developed where found.

122. *Cladonia squamosa* (Scop.) Hoffm.—Pangnirtung (D, var. *denticollis* (Hoffm.) Flk.); Cape Dorset (P).

123. *Cladonia subsericornis* (Vain.) DR.—General Distribution: eastern North America to Novaya Zemlya. Baffin Island: Cape Searle (284); Frobisher Bay (282). On soil in dry slopes of *Carex*. The plants give a characteristic P + yellow-orange reaction on the squamules. These are the first records for the Canadian Eastern Arctic.

124. *Cladonia sylvatica* (L.) Hoffm.—Pangnirtung (P). This is the rarest of the *Cladoniae* on Baffin Island and must be a southern species.

125. *Cladonia uncialis* (L.) Web.—Arctic Bay (P); Mitimatalik (T); Pond Inlet (434, B); Clyde (P); Totnes Road (S); Pangnirtung (D, P); Frobisher Bay (295); Lake Harbour (P); Cape Dorset (P). On soil among heath plants and mosses. In spite of intensive exploration this species was not found at Clyde Inlet and vicinity where it should have been common. It was replaced everywhere by *C. amaurocraea*.

Baffin Island does not have a large number of *Cladoniae*, although there is a greater number than has been found in the more northerly arctic regions. Further exploration of the southern part should turn up many of the "southern" species, as *C. carneola*, *cenotea*, *coniocraea*, *crispata*, *decorticata*, *digitata*, *norrlini*, and *scabriuscula*, all of which Dahl has collected in southwest Greenland. All of the *Cladoniae* known from Baffin Island are the common Scandinavian western species, and at the present time none of the eastern species have been discovered.

UMBILICARIACEAE

The following treatment of this family will be in accordance with Llano's (1950) recent monograph of the Western Hemisphere species. Llano divides the family into five genera on the basis of the morphology of the apothecium, which was first investigated systematically by Scholander (1934). *Agyrophora* is characterized by a plane smooth apothecial disk, or *leiodisk*; *Omphalodiscus* by a plane, centrally papillate or fissured *omphalodisk*; and *Umbilicaria* by a convex, concentrically or radially gyrate *gyrodisk*. The other two genera, *Actinogyra* and *Lasallia*, do not ordinarily occur in the arctic. Complete citations and detailed geographical distribution of the species are in-

cluded in the monograph. Llano examined all specimens of the present collection and gave assistance in constructing the key.

1. Rhizinae sparse to continuous on the lower surface.
 2. Rhizinae cylindrical; lower surface without a prominent central black spot.
 3. Upper surface plane to broadly undulating.
 4. Rhizinae attenuate, marginal or projecting past the margins; lower surface buff.
 5. Gyrodisk common; rhizinae marginal131. *U. cylindrica*
 5. Omphalodisk common; rhizinae not marginal but often projecting past the margin128. *O. virginis*
 4. Rhizinae short to long, tips enlarged; lower surface of thallus dark brown to black.
 6. Rhizinae dense, brownish; thallus with a smooth continuous lower surface137. *U. vellea*
 6. Rhizinae short, sparse; lower surface sooty black, verrucose130. *U. cinereorufescens*
 3. Upper surface strongly ridged or wrinkled.
 7. Thallus with lamellae on the lower surface136. *U. torrefacta*
 7. Thallus without lamellae, smooth below.
 8. Upper surface vermiform-wrinkled to the margin; center of thallus not prominent134. *U. hyperborea*
 8. Upper surface with ridges fading marginally; center of thallus pruinose, raised to a peak135. *U. proboscidea*
 2. Rhizinae mostly flat; lower surface sooty black with a light colored margin129. *U. aprina*
 1. Rhizinae absent on the lower surface.
 9. Upper surface with isidia132. *U. deusta*
 9. Upper surface without isidia.
 10. Gyrodisk present*U. arctica*
 10. Gyrodisk absent.
 11. Thallus fenestrate, with a central lighter pruinose spot below, sometimes extending to the margin133. *U. hawaii*
 11. Thallus not fenestrate, without a pruinose area below.
 12. Upper surface smooth, without ridges*A. rigida*
 12. Upper surface ridged and reticulate.
 13. Thallus less than 5 cm. broad, with fine reticulations on the upper surface fading marginally126. *A. lyngei*
 13. Thallus more than 5 cm.; upper surface strongly ridged, with ridges extending to the margin127. *O. decussatus*

126. *Agyrophora lyngei* (Schol.) Llano.—General Distribution: Alaska east to Novaya Zemlya. Baffin Island: Arctic Bay (521, P); Mitamatilik (T); Clyde Inlet (205); Cape Dorset (P). On gneiss rocks, frequently near bird nests or perching areas.

127. *Omphalodiscus decussatus* (Vill.) Schol.—Clyde Inlet (208); Cape Searle (505). On sheltered gneiss rocks, often with *Agyrophora lyngei*. Other Canadian Eastern Arctic reports are Cornwallis Island and Nottingham Island. It seems to be rare, although found in great abundance at Clyde Inlet, the thalli attaining a diameter of 14 cm. with many imperfect apothecia.

128. *Omphalodiscus virginis* (Schaer.) Schol.—Arctic Bay (634, P); Clyde Inlet (200); Barnes Ice Cap (315). On gneiss rocks in irrigated habitats. Some specimens were collected in standing water. In one very sheltered ravine at Clyde Inlet, talus boulders in a dry stream bed were thickly matted with this species with the thalli up to 25 cm. broad.

129. *Umbilicaria* cf. *aprina* Nyl. Syn. Lich. 2:12. 1863.—General Distribution: Abyssinia and Scandinavia. Baffin Island: Clyde Inlet (450). On exposed gneiss boulders at 300 m.; abundant and sterile. The thallus varies from 1-1.5 cm. in diameter and compares in all respects with the literature descriptions. A range extension of this old world species to North America is difficult to explain in the light of its absence from Greenland. Similar examples are *Lecanora caesiopruinosa*, *Lecidea homosema*, and *Stereocaulon capitellatum*.

130. *Umbilicaria cinereorufescens* (Schaer.) Frey.—Clyde Inlet (649). On sheltered gneiss bedrock with *U. vellea*. This is the first record for the Canadian Eastern Arctic.

131. *Umbilicaria cylindrica* (L.) Del.—Arctic Bay (458); Pond Inlet (524, D); Clyde (P); Clyde Inlet (200a); Barnes Ice Cap (206); Pangnirtung (D); Frobisher Bay (368); Lake Harbour (P); Cape Dorset (D, P). On gneiss erratics, most common in moist situations.

132. *Umbilicaria deusta* (L.) Baumg.—Cape Searle (207). On gneiss rocks in sheltered areas. A southern species in the Canadian Eastern Arctic. This is the first record for the area.

133. *Umbilicaria havaasi* Llano. Syn. *U. fuliginosa* Zahlbr.—General Distribution: western North America east to Scandinavia. Baffin Island: Frobisher Bay (459). On gneiss bedrock. Plants sterile, about 6 cm. broad. Llano reports it from Southampton and Nottingham Islands.

134. *Umbilicaria hyperborea* (Ach.) Hoffm.—Arctic Bay (382); Mitimatalik (T); Pond Inlet (353); Clyde (P); Clyde Inlet (201); Barnes Ice Cap (489); Cape Searle (395); Pangnirtung (D, P). On gneiss slopes everywhere. Talus slopes were usually covered with this species and the two following in abundance.

135. *Umbilicaria proboscidea* (L.) Schrad.—Mitimatalik (T); Pond Inlet (645, D, P); Clyde (P); Clyde Inlet (202); Barnes Cap (469); Cape Searle (506); Pangnirtung (D, P); Frobisher Bay (369); Lake Harbour (P); Cape Dorset (D, P). On gneiss boulders, very common.

136. *Umbilicaria torrefacta* (Lightf.) Schrad.—Mitimatalik (T); Pond Inlet (349); Clyde (P); Clyde Inlet (203); Barnes Ice Cap (470); Cape Searle (510); Pangnirtung (P); Frobisher Bay (370, 371). On gneiss rocks in all situations.

137. *Umbilicaria vellea* (L.) Ach.—Clyde Inlet (204). On moist gneiss bedrock. There are two other Baffin stations given by Llano: Gulf of Cumberland and Cape Dorset.

Agyrophora rigida (DR.) Llano and *Umbilicaria arctica* Nyl. are rare species in North America. Both are abundantly represented in Greenland and there is every reason to suppose that they also occur on Baffin Island. *U. arctica* is often confused with *U. hyperborea* and *proboscidea*.

ACAROSPORACEAE

138. *Acarospora badiofusca* (Nyl.) Th. Fr.—Clyde Inlet (849). On gneiss rocks in a dry stream bed, common. Apparently new to the Canadian Eastern Arctic.

139. *Acarospora chlorophana* Mass.—Cape Searle (594). On phonolite at the bird cliffs, very common. This is a highly nitrophilous species in the region.

140. *Acarospora molybdina* (Wahlb.) Trev.—Arctic Bay (P).

141. *Acarospora montana* H. Magn.—General Distribution: Europe, Scandinavia, and Greenland. Baffin Island: Clyde Inlet (372). On gneiss rocks below bird nests, abundant. A central column which usually occurs in the thecium of this species is not present. The material was determined by Magnusson. New to North America.

142. *Acarospora sinopica* (Wahlb.) Kbr.—Lake Harbour (P).

143. *Sporostatia cinerea* (Schaer.) Kbr.—Lake Harbour (P); Cape Dorset (P).

144. *Sporostatia testudinea* (Ach.) Mass.—Arctic Bay (600, P); Clyde (P); Clyde Inlet (753); Cape Searle (754). On exposed gneiss rocks, common.

PERTUSARIACEAE

The *Pertusariae* in the arctic are most abundant on partly decomposed plant remains, especially of graminoids. Since the species of the genus *Ochrolechia* are very similar in habitat and appearance, the two genera will be keyed out together. The use of KOH, Ca, and P will often serve to identify specimens and in addition separate the species into natural subgeneric groups (cf. Ericksen, 1936). The chemistry of the color reactions is still incompletely known; by the use of microchemical methods the author was able to demonstrate norstictic acid (KOH + red) in *P. coriacea* and *octomela* and gyrophoric acid (Ca +) in *Ochrolechia frigida*.

1. Apothecia lecanorine, disk expanded.

2. Apothecia sorediose; disk black to white pruinose150. *P. panyrga*

2. Apothecia not sorediose; disk pale to brown.

3. Asci with one spore145. *P. bryontha*

3. Asci with 8 spores.

4. Thallus of numerous cylindrical, perpendicular, coralloid branches. P + red 149. *P. oculata*
 4. Thallus warty to uniform or with irregular suberect coralloid branchlets.
 P. —, or P + yellow.
 5. Thallus KOH (Ca) + red.
 6. Thallus esorediose, P —.
 7. Thallus continuous to irregularly coralloid; apothecia not common,
 larger than 1.5 mm. 176. *O. frigida*
 7. Thallus of small scattered glomeruli on a translucent protothallus;
 apothecia common, usually less than 1.5 mm. 177. *O. grimmiae*
 6. Thallus soresiose, P + yellow 178. *O. inaequatula*
 5. Thallus KOH (Ca) — 179. *O. upsaliensis*
1. Apothecia punctiform or absent.
 8. Thallus of coralloid branches.
 9. Thallus P + red, Ca —.
 10. Coralloid branches chalky white, more than 3 mm. high 147. *P. dactylina*
 10. Branches grayish white, crowded, less than 3 mm. high 149. *P. oculata*
 9. Thallus P —, Ca + red 176. *O. frigida*
 8. Thallus uniform to warty.
 11. Thallus soresiose 178. *O. inaequatula*
 11. Thallus esorediose.
 12. Thallus KOH + red.
 13. Spores 2; thallus frequently yellowish 146. *P. coriacea*
 13. Spores 8; thallus not yellowish 148. *P. octomela*
 12. Thallus KOH — or yellow 151. *P. pertusa*
145. *Pertusaria bryonitha* (Ach.) Nyl.—Clyde Inlet (711). On soil and mosses
 over sheltered talus boulders, widespread. The first collection in the Canadian Eastern
 Arctic.
 146. *Pertusaria coriacea* Th. Fr.—Arctic Bay (712, P); Pond Inlet (D); Clyde
 (P); Clyde Inlet (413); Cape Searle (616); Cape Dorset (P). Over tufts of grami-
 noids in dry habitats, common.
 147. *Pertusaria dactylina* (Ach.) Nyl.—Arctic Bay (435); Pond Inlet (B, D);
 Clyde (P); Clyde Inlet (316); Frobisher Bay (460); Lake Harbour (P); Cape Dorset
 (P). On soil and plant remains in exposed areas, very common.
 148. *Pertusaria octomela* (Norm.) Erichs. (1936, p. 348)—Pond Inlet (641);
 Clyde Inlet (756). On twigs and branches of *Salix* sp., scarce but widespread. Thallus
 KOH + red, P + orange-red. Spores 8, 40-60 x 20-30 μ . As far as could be de-
 termined this is a new record for North America.
 149. *Pertusaria oculata* (Dicks.) Th. Fr.—Pond Inlet (716); Clyde (P); Clyde
 Inlet (710); Barnes Ice Cap (724); Pangnirtung (P); Cape Dorset (P). On soil and
 mosses in wet areas, common.
 150. *Pertusaria panyrga* (Ach.) Mass.—Arctic Bay (636); Pond Inlet (640);
 Clyde Inlet (403, 407); Barnes Ice Cap (642); Lake Harbour (P). Over plant
 remains in dry places, common. This proved to be one of the commonest *Pertusariae*,
 although previously collected only as far north as Lake Harbour. It is lacking from
 eastern Greenland and scarce in western Greenland, suggesting a species of eastern dis-
 tribution.
 151. *Pertusaria pertusa* (L.) Tuck.—Lake Harbour (P). "On the old wood of a
 conifer." Since there are no trees naturally growing on Baffin Island, this may be an
 accidental find.

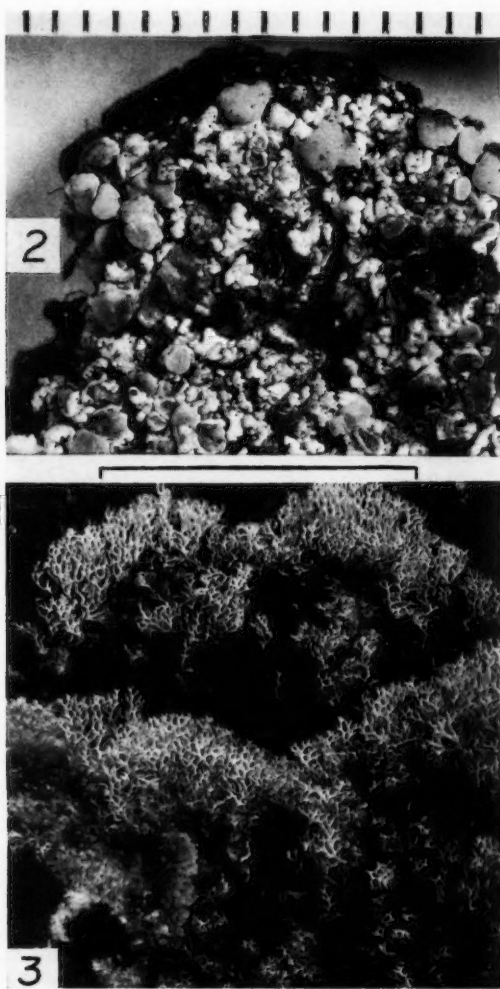
LECANORACEAE

152. *Lecanora alphoplaca* (Wahlb.) Dub.—Clyde Inlet (852). On gneiss rocks in
 sheltered areas. Thallus KOH + red. New to the Canadian Eastern Arctic but known
 from Michigan (Thomson, 1951) and several localities in western United States.
 153. *Lecanora atosulphurea* (Wahlb.) Ach.—Clyde Inlet (721). On dry gneiss
 rocks, not common. New to the Eastern Arctic.
 154. *Lecanora badia* (Hoffm.) Ach.—Pond Inlet (433); Clyde Inlet (317; 693, f.
pallida Flot. det. Magnusson); Cape Searle (499). On gneiss bird perches or moist
 rocks (f. *pallida*); at Cape Searle on phonolite.
 155. *Lecanora behringii* Nyl.—Clyde Inlet (759). On old bones and caribou
 antlers, very common. Unreported from the Canadian Eastern Arctic and perhaps from
 North America.

156. *Lecanora bicincta* Ram.—Cape Dorset (P).
157. *Lecanora caesiopruinosa* H. Magn. Arkiv Bot. 1952.—Cape Searle (501). On phonolite at the bird cliffs, abundant. Determined by Magnusson. New to North America and the second locality.
158. *Lecanora canadensis* Lynge & Magn.—Arctic Bay (P). Unfortunately this species, described in *Polaria* (1947), was not rediscovered.
159. *Lecanora castanea* (Hepp) Th. Fr.—Pond Inlet (774); Clyde Inlet (699); Frobisher Bay (714). Over mosses in sheltered habitats, common. New to the Canadian Eastern Arctic where it is probably as common as in other arctic regions. The apothecia vary from shiny brown to quite pruinose.
160. *Lecanora epibryon* Ach.—Arctic Bay (796); Pond Inlet (P); Clyde Inlet (417); Cape Searle (717); Lake Harbour (P). Over mosses and plant remains, usually in moist habitats, very often growing with *Rimodina turfacea*, common.
161. *Lecanora flavida* Hepp—Arctic Bay (749); Pond Inlet (721); Clyde Inlet (720). On limestone and marble, common. This inconspicuous, though ubiquitous, species was previously recorded only from Ellesmere.
162. *Lecanora frustulosa* (Dicks.) Ach.—Clyde Inlet (550). On sheltered gneiss outcrops, not common. The specimens can probably be referred to var. *argopholis* (Wahlb.) Kbr.
163. *Lecanora gelida* (L.) Ach.—Clyde Inlet (692); Barnes Ice Cap (653); Cape Searle (579). On moist irrigated gneiss or mica schists. Very common on the wet gravel flats around the Ice Cap and in exposed areas.
164. *Lecanora intricata* (Schröd.) Ach.—Clyde Inlet (750). On gneiss or schistose rocks, moderately nitrophilous.
165. *Lecanora lacustris* (With) Th. Fr.—Clyde Inlet (762); Barnes Ice Cap (559). On irrigated gneiss rocks, common. The thallus is distinct although according to Lynge it is ordinarily thin or lacking in arctic material. The small apothecia and spores ($14 \times 8 \mu$) exclude *L. poluninii*. New to the Canadian Eastern Arctic.
166. *Lecanora maxima* Lynge (1937, p. 126).—Clyde Inlet (611). On mosses in depressions and cracks of steep bedrock exposures, infrequently irrigated, abundant where found. This most conspicuous *Lecanora* agrees perfectly with Lynge's description and illustration, differing only in having spores on the average 1μ smaller and pycnides $1-3 \mu$ shorter. It was previously known only from the type locality in western Greenland and probably represents an American species.
167. *Lecanora melanaspis* (Ach.) Th. Fr.—Clyde Inlet (328). On irrigated gneiss rocks with *Caloplaca elegans* (no. 325), very common along rivers. Specimens agree perfectly with Magnusson's *Plantae Scand.* 3471. New to the Canadian Eastern Arctic.
168. *Lecanora melanophthalma* Ram. Syn. *L. peltata* Zahlbr. *L. subpeltata* Lynge. *L. melanophthalma* var. *subpeltata* Lynge.—Arctic Bay (488); Cape Searle (504, 792). On gneiss bird perches; on phonolite at the bird cliffs. Lynge (cf. 1940) became increasingly doubtful about *L. melanophthalma* and *L. peltata*, the latter "species" differentiated only by the pale color of the apothecial disk. He admitted finding both black and pale apothecia on the same thallus; the present author observed this phenomenon often at Cape Searle, where this group was extremely abundant. After studying a number of specimens, the author concluded that *L. peltata* sensu Zahlbr. and *L. subpeltata* are best regarded as color phases of this variable species. Selected specimens (e.g., Cape Searle 792) certainly do tempt one to segregate out plants with pale apothecia but an objective study emphasizes the intergradations. Dickie's report of *L. rubina* from the same locality doubtless stands for the present species.
169. *Lecanora myrini* (Fr.) Nyl.—Cape Dorset (P).
170. *Lecanora cf. pertusa* Lynge (1940, p. 88).—Clyde Inlet (694). On irrigated gneiss rocks, abundant. No material was available for comparison but there is good agreement with Lynge's description and illustration. This species is known only from eastern Greenland. New to North America.
171. *Lecanora polytropis* (Ehrh.) Rabh.—Arctic Bay (P); Clyde (P); Clyde Inlet (584); Cape Searle (612); Barnes Ice Cap (551); Pangnirtung (P); Frobisher Bay (555); Cape Dorset (P). On exposed gneiss rocks, common everywhere. *F. illusior* (Ach.) Leight. is frequent in localities without nitrophilous influences.
172. *Lecanora sordida* (Pers.) Th. Fr.—Cape Searle (199). On phonolite at the bird cliffs. Specimens very well developed: Thallus white, thick, KOH + yellow; apothecia very numerous, disk Ca + yellow. New to the Canadian Eastern Arctic.

173. *Lecanora* cf. *suplapponica* Zahlb.—Clyde Inlet (765). On irrigated gneiss rocks, common. Anatomically the plants agree well with descriptions, but the apothecia seem more prominent than usual. New to North America.

174. *Lecanora superfluens* H. Magn. (1952, p. 46).—Clyde Inlet (416). On moist sandy soil, abundant locally. A sterile thallus, apparently referable to this species,



Figs. 2, 3.—2. *Lecanora superfluens* H. Magn. n. sp. (Hale, no. 416, cotype). Scale in mm. 3. *Parmelia separata* Th. Fr. in the natural habitat at Camp B, head of Clyde Inlet. Scale 15 cm.

is very common in tiny clumps cementing sand grains in the barrens of outwash. This distinctive species (Fig. 2) resembles *L. lentigera* somewhat.

175. *Lecanora verrucosa* (Ach.) Laur.—Clyde Inlet (718). On mosses in sheltered habitats, not common. Lyngé's repeated statements of the commonness of this species in the arctic does not hold for the Canadian Eastern Arctic.

The above 24 species of *Lecanora* cannot represent more than one-third of the total number on Baffin Island. Many of the *Aspicillae* await determination and should increase this number substantially. The American student is constantly hindered by the lack of suitable comparison material for this difficult genus.

176. *Ochrolechia frigida* (Sw.) Lyngé.—Arctic Bay (632, P); Pond Inlet (648, P); Clyde (P); Clyde Inlet (409, f. *thelophoroides* Arn.; 410); Cape Searle (624); Pangnirtung (P); Frobisher Bay (729); Lake Harbour (P); Cape Dorset (P). Over plant remains, very common.

177. *Ochrolechia grimmiae* Lyngé. (1928, p. 184).—General Distribution: Novaya Zemlya, Spitsbergen, Jan Mayen. Baffin Island: Clyde Inlet (406). Over *Rhacomitrium* sp., rare, but abundant locally. Thallus of glomeruli scattered over a thin continuous protothallus; apothecia numerous, 0.5-1.5 mm. Habitually it seems quite distinct from *O. frigida*. New to North America.

178. *Ochrolechia inaequatula* (Nyl.) Zahlbr.—Pond Inlet (P).

179. *Ochrolechia upsaliensis* (L.) Mass.—Arctic Bay (630); Pond Inlet (638, P); Clyde Inlet (411); Lake Harbour (P). Over plant remains, not common but widespread.

The key to *Ochrolechia* has already been given under the Pertusariaceae.

180. *Lecania alpinvaga* Th. Fr. Lich. Scand. 1:292. 1874.—General Distribution: Scandinavia, Novaya Zemlya. Baffin Island: Clyde Inlet (681). On soil and with mosses in moist sheltered habitats, common and abundant where found. The plants are uncommonly well developed, according to Magnusson, who determined them. New to North America.

181. *Haematomma ventosum* (L.) Mass.—Pond Inlet (P); Clyde Inlet (276); Barnes Ice Cap (468); Pangnirtung (P); Frobisher Bay (365); Lake Harbour (P); Cape Dorset (P). On exposed gneiss boulders, very common. The thallus in all plants is P—(var. *lapponicum* (Räs.) Lyngé). It is perhaps moderately nitrophilous, especially abundant on bird perches.

182. *Candelariella epixantha* (Ach.) Sandst.—Clyde Inlet (573). On old bones and antlers, rarely on plant remains.

183. *Candelariella placodiizans* (Nyl.) H. Magn.—Arctic Bay (660, P); Pond Inlet (650, P); Clyde Inlet (578); Lake Harbour (P). On soil over talus boulders, often with *Lecidea rubiformis*, very common.

184. *Candelariella vitellina* (Ehrh.) Müll. Arg.—Clyde Inlet (864); Cape Searle (606).

PARMELIACEAE

185. *Parmeliopsis ambigua* (Wulf.) Nyl.—Pond Inlet (P).

PARMELIA Ach.

1. Thallus yellow; usnic acid present.
 2. Thallus with soredia on the upper surface 191. *P. incurva*
 2. Thallus esorediate.
 3. Underside of thallus white; lobes appressed, I — 188. *P. centrifuga*
 3. Underside of thallus dark, lead colored to black; lobes loosely attached, I + blue 197. *P. separata*
1. Thallus greenish gray to dark brown; usnic acid lacking.
 4. Thallus with soredia or isidia.
 5. Lobes sorediate.
 6. Lobes inflated, hollow; no rhizinae below 195. *P. physodes*
 6. Lobes not inflated, solid; with rhizinae below.
 7. Soredia in elongate patches; thallus light greenish gray to reddish 199. *P. sulcata*
 7. Soredia in circular patches, originating from inconspicuous isidia; thallus dark brown to black 189. *P. disjuncta*
 5. Thallus lobes with isidia.
 8. Thallus brown or mottled brown and gray.
 9. Thallus mottled brown, hollow 187. *P. austerodes*
 9. Thallus uniformly brown, solid.

10. Thallus with small clavate isidia; on bark 190. *P. exasperatula*
 10. Thallus with large cylindrical isidia; on stones and mosses 192. *P. infumata*
 8. Thallus greenish gray 196. *P. saxatilis*
 4. Thallus without isidia or soredia.
 11. Thallus inflated, without rhizinae below.
 12. Lobes more than 2 mm. broad, hollow.
 13. Lobes mottled brown and grayish *P. subobscura*
 13. Lobes uniformly light greenish gray 195. *P. physodes*
 12. Lobes less than 2 mm. broad, solid 193. *P. intestiniformis*
 11. Thallus not inflated, with rhizinae below.
 14. Thallus dark greenish gray to black; lobes narrow, imbricate to continuous 186. *P. alpicola*
 14. Thallus brown; lobes discrete.
 15. Thallus with numerous pycnidia on the upper surface; ends of lobes rounded, shiny 198. *P. stygia*
 15. Thallus with few scattered pycnidia; ends of lobes angular, dull brown to gray 194. *P. omphalodes*
 186. *Parmelia alpicola* Th. Fr.—Clyde (P); Clyde Inlet (249; 271, c. fr.); Barnes Ice Cap (493); Frobisher Bay (512); Lake Harbour (P); Cape Dorset (P). On exposed gneiss, especially in the fellmark.
 187. *Parmelia austerodes* Nyl.—Pond Inlet (452); Clyde Inlet (253, det. Degelius). Over mosses and plant remains in *Carex* meadows and heaths, very common. There exists some doubt whether *P. subobscura* is distinct from this species. Dahl (1950) reported atronorine in *P. austerodes* but not in *subobscura*. The author found atronorine in the Pond Inlet material, which, however, lacks any sign of isidia. *P. subobscura* may have papillate outgrowths and intermediate forms are just as easily referable to *P. austerodes*. The two species may of course differ in habitat requirements and the final solution to the problem will require more field work.
 188. *Parmelia centrifuga* (L.) Ach.—Clyde Inlet (254, 256; 331, var. *groenlandica* (Lyngé) Lyngé); Pangnirtung (P); Lake Harbour (P); Cape Dorset (P). On sheltered gneiss rocks, common. A distinctly southern and continental species. Var. *groenlandica* occurs often on moist exposed rocks.
 189. *Parmelia disjuncta* Erichs. Syn. *P. granulosa* Lyngé.—Arctic Bay (488); Clyde Inlet (340, det. Degelius). On gneiss in exposed situations.
 190. *Parmelia exasperatula* Nyl.—Clyde Inlet (332). On bark of an old *Salix* shrub in a ravine. Determined by Degelius. New to the Canadian Eastern Arctic.
 191. *Parmelia incurva* (Pers.) Th. Fr.—Clyde (P); Clyde Inlet (238); Barnes Ice Cap (484); Frobisher Bay (442). On gneiss rocks, especially in exposed areas, common.
 192. *Parmelia infumata* Nyl.—General Distribution: Canadian Arctic to Novaya Zemlya, Baffin Island: Arctic Bay (381); Pond Inlet (456); Clyde Inlet (255); Cape Searle (430). On gneiss rocks and over mosses at bird perches, common.
 193. *Parmelia intestiniformis* (Vill.) Ach.—General Distribution: Canadian Arctic east to Novaya Zemlya. Baffin Island: Pond Inlet (B); Clyde Inlet (251); Barnes Ice Cap (487). On sheltered gneiss rocks, abundant where found but not common.
 194. *Parmelia omphalodes* (L.) Ach.—Arctic Bay (778); Pond Inlet (B); Clyde (P); Clyde Inlet (236); Barnes Ice Cap (486); Cape Searle (427); Frobisher Bay (666). Over mosses and on rocks, very common.
 195. *Parmelia physodes* (L.) Ach.—Pond Inlet (P); Clyde Inlet (311). On soil in heaths and in *Carex* meadows or over mosses on rocks. The Clyde Inlet specimen, determined by Degelius, is esorediose and P + orange-red.
 196. *Parmelia saxatilis* (L.) Ach.—Arctic Bay (380); Pond Inlet (639, P); Clyde Inlet (855); Pangnirtung (D); Lake Harbour (P); Cape Dorset (P). Over mosses and plant remains and on sheltered rocks.
 197. *Parmelia separata* Th. Fr. Syn. *P. birulae* Elenk.—General Distribution: Novaya Zemlya east to Baffin Island (one station in northwest Greenland). Baffin Island: Mitimatalik (T); Pond Inlet (518, B); Clyde Inlet (250, 307); Frobisher Bay (784). On dry gneiss rocks, occasionally over mosses, in very sheltered habitats, abundant locally and widespread (fig. 3). Quite common in the area and strictly continental in distribution.

198. *Parmelia stygia* (L.) Ach.—Barnes Ice Cap (858). On sheltered gneiss, not common.

199. *Parmelia sulcata* Tayl.—Pond Inlet (B, D); Clyde Inlet (252, 329); Barnes Ice Cap (485); Pangnirtung (P); Frobisher Bay (664); Lake Harbour (P). Over mosses and soil and on rocks, frequently near bird perches, very common.

CETRARIA Ach.

1. Thallus yellow to greenish yellow.

2. Thallus broad, foliose, growing horizontally.

3. Medulla I —; margins of lobes smooth200. *C. chrysantha*

3. Medulla I +; margins sorediate, irregular205. *C. glauca*

2. Thallus narrow, fruticose, usually growing erect.

4. Thallus lemon yellow; plants growing in calcareous habitats211. *C. tilesii*

4. Thallus yellow; plants not confined to calcareous soils.

5. Surface of thallus reticulate, concave; bases yellow-orange210. *C. nivalis*

5. Surface of thallus smooth, involute; bases dark red203. *C. cucullata*

1. Thallus brown to dark-olivaceous.

6. Thallus lobed, foliose to subfruticose, growing horizontally.

7. Plants growing on rock.

8. Underside of thallus dark; medulla P + red206. *C. hepaticon*

8. Underside of thallus light; medulla P —201. *C. commixta*

7. Plants growing over mosses on the ground.

9. Thallus light green, with sorediate margins205. *C. glauca*

9. Thallus esorediate, margins ciliate; dark brown208. *C. nigricans*

6. Thallus not lobed, fruticose and growing erect.

10. Medulla I + blue; bases of thallus red.

11. Medulla P + red-orange207. *C. islandica*

11. Medulla P —202. *C. crispa*

10. Medulla I —; bases not red, usually pale.

12. Thallus large, 4-6 cm. high, loosely attached to the substratum; brown to pale straw colored with numerous white pseudocyphellae204. *C. delisei*

12. Thallus smaller, less than 3 cm. high, firmly attached, dark olivaceous brown to blackish; pseudocyphellae rare and inconspicuous209. *C. nigricans*

200. *Cetraria chrysantha* Tuck.—General Distribution: Canadian Eastern Arctic west to Novaya Zemlya. Baffin Island: Frobisher Bay (215). Over mosses and plant remains on dry *Carex* slopes, very abundant; sterile. This collection extends the range of another eastern species to Baffin Island. It is probably continental, as indicated by its absence from other southern coastal stations.

201. *Cetraria commixta* (Nyl.) Th. Fr. Syn. *C. fahlnensis* Vain.—Clyde Inlet (310). On soil and mosses on talus boulders, not common and sterile.

202. *Cetraria crispa* (Ach.) Nyl.—Mitimatalik (T); Pond Inlet (P); Clyde (P); Cape Searle (431); Totnes Road (S); Pangnirtung (P). Over plant remains in *Carex* meadows.

203. *Cetraria cucullata* (Bell.) Ach.—Arctic Bay (P); Mitimatalik, Albert Harbour, James Creek, Qilalukan (T); Pond Inlet (658, D, P, T); Clyde (D, P); Clyde Inlet (212, 267, 268); Barnes Ice Cap (475); Cape Searle (424); Totnes Road (S); Pangnirtung (P); Frobisher Bay (438); Lake Harbour (P); Cape Dorset (D, P). On the ground with *Carex* or in heaths, common everywhere.

204. *Cetraria delisei* (Bory) Th. Fr.—Arctic Bay (384); Mitimatalik (T); Pond Inlet (B); Clyde (P); Clyde Inlet (219); Barnes Ice Cap (481); Pangnirtung (P); Frobisher Bay (523); Lake Harbour (P); Cape Dorset (P). On wet or exposed soil, common.

205. *Cetraria glauca* (L.) Ach.—Cape Dorset (P).

206. *Cetraria hepaticon* (Ach.) Vain.—Clyde Inlet (308, 309, 330); Barnes Ice Cap (495); Pangnirtung (D, P); Frobisher Bay (869). On sheltered gneiss rocks, common. The Clyde Inlet plants were confirmed by Degelius.

207. *Cetraria islandica* (L.) Ach.—Arctic Bay (P); Pond Inlet (360); Clyde Inlet (213); Barnes Ice Cap (483); Frobisher Bay (366); Lake Harbour (P); Cape Dorset (P). On ground with heath plants and *Carex* spp., common. The collection from Clyde Inlet included some magnificent plants, up to 15 cm. high.

208. *Cetraria nigricans* Nyl.—Clyde (P); Clyde Inlet (220, 221); Barnes Ice Cap

(496); Cape Dorset (P). On soil and among mosses, especially common on talus boulders; rarely fruiting. This species is obviously more common than the few previous records indicated. Numbers 220 and 221 determined by Imshaug.

209. *Cetraria nigricascens* Elenk. Memoir. Acad. Imp. Sci. St. Peterbourg, classe phys.-math. 27:14, 1909. Syn. ?*Platysma nigricascens* Nyl. Medd. Soc. F. Fl. Fenn. 18:50, 1891.—General Distribution: Siberia and Franz Joseph Land. *Baffin Island*: Clyde Inlet (306). Fig. 4. On soil and mosses in a late snowpatch area with *Salix herbacea* and *Lycopodium selago*. This interesting species was identified by direct comparison with the Hochstetter material (Franz Joseph Land) by Imshaug. It is a doubt-



Figs. 4, 5.—4. *Cetraria nigricascens* Elenk. (Hale, no. 306). Scale in mm.
5. *Evernia perfragilis* f. *soredica* Hale n. f. (Hale, no. 214). Scale in mm.

ful species, as Elenkin himself (1912) points out. After investigations by Savicz, it was shown that the specimens of *C. nigricascens* from the collection of Kihlman, which was identified by Nylander and examined by Vainio, was nothing but an aberrant form of *C. delisei*. It was not known if Nylander described this as a new species or not. Without access to the type the question could not be answered and Elenkin suggested the name of the species might be *C. nigricascens* Elenk. non Nyl., which the present author has decided to use. The plants differ habitually from typical *C. delisei* in growing in small tufts firmly anchored to mosses; the thallus is rarely more than 2 (2.5) cm. high. The color is a peculiar dark olivaceous brown to black, although the bases may be considerably lighter. The ends of the erect thallus, less than 1.5 mm. wide, are sometimes dichotomously branched and resemble the terminal lobes of *C. hepaticum*, or in other cases end in spinules 0.5-1.5 mm. long, which also occur sparsely on the edges of the thallus. Apparently new to North America.

210. *Cetraria nivalis* (L.) Ach.—Arctic Bay (P); Mitimatalik, Albert Harbour (T); Pond Inlet (B, D); Clyde (D, P); Clyde Inlet (211, 270); Barnes Ice Cap (474); Cape Searle (423); Totnes Road (S); Pangnirtung (P); Frobisher Bay (362); Lake Harbour (D, P); Cape Dorset (D, P). On soil and among heath plants everywhere. Undoubtedly the most common and conspicuous of lichens along with *C. cucullata* and *Cladonia mitis*. It was found frequently in the fellmark to 1600 m.

211. *Cetraria tilesii* Ach.—Arctic Bay (457, D); Pond Inlet (D, P); Clyde Inlet (210). On soil and with mosses over calcareous rocks, abundant, even in the fellmark. A highly calciphilous species.

USNEACEAE

212. *Dactylina arctica* (Hook.) Nyl.—Pond Inlet (D, P); Clyde (P); Clyde Inlet (240, 275); Barnes Ice Cap (466); Cape Searle (508); Pangnirtung (D, P); Frobisher Bay (367); Lake Harbour (P); Cape Dorset (D, P). Among mosses and *Cassiope* in dense sheltered heaths, often in wet places, common.

213. *Dactylina ramulosa* (Hook.) Tuck.—Arctic Bay (633, P); Pond Inlet (B, D, P); Clyde (P); Clyde Inlet (401, c. fr.); Barnes Ice Cap (464); Cape Searle (393, c. fr.); Pangnirtung (P); Frobisher Bay (385); Lake Harbour (P); Cape Dorset (P). On soil or among mosses in exposed areas or near late snow patches at high elevations, common and often fruiting. Fertile *D. ramulosa* seems to be rare in other arctic lands; on Baffin Island fertile plants were common with apothecia up to 6 mm. in diameter.

214. *Cornicularia aculeata* (Schreb.) Ach.—Arctic Bay (383); Pond Inlet (352); Clyde Inlet (223, 272); Cape Searle (421); Lake Harbour (P); Cape Dorset (P). On soil in exposed areas, common, especially on clay.

215. *Cornicularia divergens* Ach.—Arctic Bay (356); Mitimatalik, Albert Harbour (T); Pond Inlet (P); Clyde Inlet (224, 225); Barnes Ice Cap (625); Cape Searle (422); Pangnirtung (P); Lake Harbour (P); Cape Dorset (P). Over plant remains in heaths, very common. Robust more or less erect forms were often found on tops of large bird perches.

216. *Evernia perfragilis* Llano (1951, p. 199). Syn. *Alectoria* (?) *arctica* Elenk. & Sav. (1912, p. 73); *Evernia arctica* (Elenk. & Sav.) Lynge; not *E. arctica* (Hook.) Tuck.—General Distribution: Canadian Eastern Arctic west to Novaya Zemlya. Baffin Island: Clyde Inlet (222). Among tufts of *Carex* spp. in exposed outwash plains, very common. This represents another problematic eastern species. Llano examined the material and concluded that it was identical with his *E. perfragilis*. Lynge was the first to study critically the species but unfortunately left it in doubt (Lynge, 1928, 1935, 1940); that is, it is still not possible to state the exact relationship of *E. perfragilis* to *E. esorediosa* (Müll. Arg.) DR. and intermediates. The Clyde Inlet collection corresponds best with Lynge's 1928 descriptions, having a thallus less than 1.5 mm. in diam., a cortex mostly less than 50 μ thick, and the plant characterized by extreme brittleness in the field so that it was often difficult to collect good specimens.

Another collection from Clyde Inlet differed from existing descriptions by the presence of soredia and these plants are proposed as a new form:

Evernia perfragilis f. *soredica* Hale, n. f. A typo differt ramis apice sorediis numerosis instructis.

Baffin Island: Head of Clyde Inlet 1950, M. E. Hale Jr. (no. 214), among tufts of *Carex* spp. in barren outwash plains. Fig. 5.

Anatomically the thallus is identical with 222 but differs in having many soredial patches 0.3-2 mm. long, to 0.8 mm. wide, much as in *Cladonia cornuta*, often confluent,

0.1-0.3 mm. thick, making the ends of the branches appear swollen. The soredia usually occur only on the extreme 4-6 mm. of the branches and seem in cross section to originate normally. There is no sign of isidia which also distinguishes it, along with fragility of the thallus, from typical *E. mesomorpha* Nyl. and varieties. In North America *E. mesomorpha* has a lax thallus with conspicuous isidia which at length become sorediate; it is a corticolous species rarely going beyond the tree zone.

217. *Alectoria chalybeiformis* (L.) Röhl.—Arctic Bay (D).

218. *Alectoria lanca* (Ehrh.) Vain. Syn. *A. nitidula* (Th. Fr.) Vain.—Arctic Bay (D); Pond Inlet (D, P); Pangnirtung (D, P); Frobisher Bay (344, suggested by Degelius); Cape Dorset (P). Over plant remains in heaths.

219. *Alectoria minuscula* Nyl.—Arctic Bay (600); Clyde Inlet (355, conf. Degelius); Barnes Ice Cap (840); Cape Searle (683). On gneiss rocks, very common in exposed areas. This is the pioneer species along with *Rhizocarpon* spp. on newly exposed rocks.

220. *Alectoria nigricans* (Ach.) Nyl.—Arctic Bay (356); Pond Inlet (785, P); Clyde (P); Clyde Inlet (334, conf. Degelius); Barnes Ice Cap (480); Pangnirtung (D, P); Frobisher Bay (515); Lake Harbour (P); Cape Dorset (P). On soil over rocks and over plant remains, widespread.

221. *Alectoria ochroleuca* (Ehrh.) Nyl.—Arctic Bay (D, P); Mitimatalik, Albert Harbour, Jones Creek (T); Pond Inlet (B, D, P); Clyde (D, P); Clyde Inlet (216; 217, c. fr.); Barnes Ice Cap (479); Cape Searle (728); Pangnirtung (D, P); Frobisher Bay (519); Lake Harbour (D, P); Cape Dorset (P). On soil and over plant remains everywhere.

222. *Alectoria pubescens* (L.) Howe.—Mitimatalik (T); Clyde (P); Clyde Inlet (248, 335, 336, all conf. Degelius); Barnes Ice Cap (861); Pangnirtung (D, P). On talus boulders in sheltered areas.

223. *Neurogogon sulphureus* (König) Hellb.—Cape Searle (283). On non-calcareous rocks near the bird cliffs, very abundant locally. This is the southernmost locality outside of Iceland for this remarkable lichen. Dickie's report of it from the same station (sub. nom. *N. melaxantha*) was not mentioned by Lynge (1941; in Polunin, 1947). It was not observed below 275 m. elevation which may be correlated with the level of sea fog in the vicinity.

CALOPLACACEAE

224. *Protoblastenia rupestris* (Scop.) Stein.—General Distribution: eastern North America to Novaya Zemlya. *Baffin Island*: Cape Searle (770). On phonolite at the bird cliffs.

225. *Blastenia tetraspora* (Nyl.) Rehm.—Lake Harbour (P).

226. *Fulgensia bracteata* (Hoffm.) Räs.—General Distribution: North America east to Scandinavia. *Baffin Island*: Arctic Bay (P); Clyde Inlet (323, c. fr.); Lake Harbour (P). On soil and over mosses in exposed areas, widespread.

CALOPLACA Th. Fr.

1. Thallus crustose or absent.

2. Plants growing on bark or over plant remains.

3. Margin of apothecium pulverulent, gray 236. *C. stillicidiorum*

3. Margin of apothecium not pulverulent, concolorous with disk.

4. Disk orange-ochraceous.

5. Apothecia up to 2 mm., margin becoming crenulate 232. *C. jungermanniae*

5. Apothecia less than .7 mm., margin not crenulate but smooth and entire

..... 237. *C. subolivacea*

4. Disk darker, ferrugineous.

6. Disk convex, plants often growing over plant remains and mosses 227. *C. cinnamomea*

6. Plants growing on bark, disk plane 230. *C. ferruginea*

2. Plants growing on stone.

7. Thallus yellowish 234. *C. pyraea*

7. Thallus ashy to gray 231. *C. festiva*

1. Thallus foliose to squamulose, lobed.

8. Thallus with soredia.

9. Thallus small, less than 1 mm. broad (thalli confluent often) 228. *C. cirrochroa*

9. Thallus large, 1-2 cm. broad 235. *C. sorediata*

8. Thallus esorediate.

10. Thallus lobes large, 5 mm.-2 cm. long, often loosely attached229. *C. elegans*

10. Thallus lobes small, less than 1.5 mm. long, closely appressed

.....233. *C. murorum*227. *Caloplaca cinnamomea* Th. Fr.—Clyde Inlet (580); Cape Searle (622); Lake Harbour (P); Cape Dorset (P). Over mosses and plant remains.228. *Caloplaca cirrochroa* Th. Fr.—General Distribution: North America, Scandinavia. Baffin Island: Cape Searle (688). On phonolite at the bird cliffs. Thallus small, less than 1 mm. broad, often confluent, sparse to diffuse sorediate. Apothecia rare, less than .5 mm. broad; spores 10-15 x 6-9 μ . New to the Canadian Eastern Arctic and apparently to arctic regions.229. *Caloplaca elegans* (Link) Th. Fr.—Arctic Bay (527, D, P); Mitimatalik (T); Pond Inlet (659, B); Clyde Inlet (325); Cape Searle (500); Lake Harbour (P). On gneiss erratics; on phonolite at the bird cliffs. Often very abundant on rocks in streams at the high water level along with *Lecanora melanaspis*.230. *Caloplaca ferruginea* (Huds.) Th. Fr.—Clyde Inlet (742). On bark of an old *Salix* shrub. Probably var. *ferrugineofusca* Vain., although the thallus is more distinct than usual.231. *Caloplaca festiva* (Fr.) Zw.—Clyde Inlet (743). On a sheltered exposure of marble, not abundant. New to the Canadian Eastern Arctic.232. *Caloplaca jungermanniae* (Vahl) Th. Fr.—Clyde Inlet (547); Lake Harbour (P).233. *Caloplaca murorum* Th. Fr.—Cape Searle (420). On phonolite at the bird cliffs, with *Xanthoria fallax*.234. *Caloplaca pyracea* (Ach.) Th. Fr.—Clyde Inlet (854). On gneiss pebbles in a moist habitat.235. *Caloplaca sorediata* (Vain.) DR.—Pond Inlet (P); Lake Harbour (P).236. *Caloplaca stillicidiorum* (Vahl) Lynge.—Clyde Inlet (577). Over plant remains in all situations, very common.237. *Caloplaca subolivacea* (Th. Fr.) Lynge.—Clyde Inlet (548); Cape Searle (614). Over plant remains, widespread.

THELOSCHISTACEAE

238. *Xanthoria candelaria* (L.) Arn.—Pond Inlet (529, B); Clyde Inlet (237, 263). On gneiss rocks and over mosses near bird nests or perching areas. Probably a widespread nitrophilous species on Baffin Island. In one collection (263) made at 300 m. in exposed fellmark, plants were growing on rocks and mosses in a dried up stream bed; the lobes are exceptionally large, up to 1-2 x 4-6 mm. All specimens sterile.239. *Xanthoria fallax* (Hepp) Arn.—Clyde Inlet (471); Cape Searle (419). On gneiss; on phonolite at the bird cliffs. These seem to be the first arctic records for this nitrophilous species.

BUELLIACEAE

240. *Buellia microplaca* (Vain.) Erichs.—Arctic Bay (P). After examining Lynge's plant in the Farlow Herbarium, Dr. Imshaug feels this collection is a parasitized lichen, not a *Buellia*.241. *Buellia moriopsis* (Mass.) Th. Fr. Lich. Scand. 606. 1874. Syn. *B. atrata* (Sm.) Anzi.—Clyde (P); Lake Harbour (P); Cape Dorset (P).242. *Buellia papillata* (Sommerf.) Tuck. Lich. California 26. 1866. Syn. *B. bryophila* Kbr. *B. disciformis* var. *muscorum* (Hepp) Vain. *B. geophila* (Sommerf.) Lynge. *B. insignis* (Naeg.) Th. Fr.—General Distribution: (in North America) Baffin Island west to the Rocky Mountains. Baffin Island: Arctic Bay (794); Clyde Inlet (575); Lake Harbour (P). Over plant remains and on soil in sheltered areas, common. No. 575 determined by Imshaug, who gave the synonymy of this and the preceding species.243. *Buellia scabrosa* (Ach.) Kbr.—Clyde Inlet (758, det. Imshaug). On the thallus of *Baeomyces placophyllus*. New to the Canadian Eastern Arctic.Lynge's conviction that a trained lichenologist could find 20 or more species of *Buellia* in a summer did not seem reasonable to the author. On the contrary the genus is very poorly represented in spite of efforts made during the expedition to collect all

species. Similar statements by Lyngbe regarding the probable abundance or rareness of a species often reflect his experience in Scandinavian western arctic regions.

RINODINA (S. Gray) Mass.

1. Thallus crustose, uniform.
2. Plants growing on calcareous rocks 244. *R. bischoffii*
2. Plants growing on soil or plant remains.
3. Apothecia pruinose, less than 1 mm. broad 248. *R. rosida*
3. Apothecia epruinose, more than 1 mm.
4. Apothecia plane, hymenium about 100 μ 249. *R. turfacea*
4. Apothecia convex, hymenium 130-150 μ 245. *R. mniaraea*
1. Thallus crustose and marginally lobed to squamulose.
5. Thallus yellow; on stones 247. *R. oreina*
5. Thallus brown to more or less white pruinose; over mosses and soil 246. *R. nimbosa*

244. *Rinodina bischoffii* (Hepp) Mass.—Pond Inlet (862). On limestone, scarce. The material is fragmentary but the spore characters (16-21 x 10-14 μ , medial zone dark, unstricted) leave little doubt as to its identity.

245. *Rinodina mniaraea* (Ach.) Kbr.—Clyde Inlet (581). Over mosses and plant remains, rare.

246. *Rinodina nimbosa* (Fr.) Th. Fr.—Clyde Inlet (415); Cape Searle (392). Over mosses in sheltered ravines, common. Previously collected only on Melville Peninsula.

246a. *Rinodina nimbosa* var. *sphaerocarpa* Th. Fr. Lich. Scand. 193. 1874.—Clyde Inlet (746). On soil over talus boulders. Distinguished from var. *nimbosa* by its strongly convex immarginate apothecia and white pruinose lobes. Determined by Imshaug.

247. *Rinodina oreina* (Ach.) Mass. Syn. *R. oreina* sensu Lyngbe. *R. hueana* Vain. *R. oreina* var. *hueana* (Vain.) Zahlbr.—General Distribution: (in North America) central Canada, west and southwest United States east to Greenland; and Baffin Island south to the 32° parallel. Baffin Island: Arctic Bay (488, P); Clyde Inlet (279). On gneiss rocks, probably bird perches, widespread. All plants were P —, KOH —, Ca —, I + blue in cortex and medulla. After an intensive study of this species in North America the author (1952) concluded that there is no valid specific character which can separate out *R. hueana*. The investigations revealed three chemically dissimilar groups or strains in the plants, which are identical morphologically: 1. P + C — (protocetraric (?)) and usnic acids; 2. P — C + (gyrophoric and usnic acids); 3. P — C — (usnic acid).

Groups 1 and 2 typically grow intermixed in the temperate deciduous forest and it is proposed that they be called Chemical Strains I and II respectively of *R. oreina*, following Lamb's (1951) recent proposals. Group 3 is apparently the inactive or acid-free phase of Chemical Strain II, and both of these may occur in the prairies, Rocky Mountains, and the arctic. Groups 1 and 3 do not grow together.

248. *Rinodina rosida* (Sommerf.) Arn.—Arctic Bay (P).

249. *Rinodina turfacea* (Wahlb.) Kbr.—Pond Inlet (667); Clyde Inlet (321); Barnes Ice Cap (747). Over mosses and plant remains, very common, especially with *Lecanora epibryon*.

PHYSICIACEAE

250. *Physcia caesia* (Hoffm.) Hampe.—Pond Inlet (348); Clyde Inlet (337). On gneiss rocks; on an old *Salix* shrub at Clyde Inlet.

251. *Physcia constipata* (Nyl.) Norrl. & Nyl.—Arctic Bay (346). With mosses on a gneiss bird perch. Determined by Degelius. New to the Canadian Eastern Arctic.

252. *Physcia dubia* (Hoffm.) Lettau—Clyde Inlet (338); Cape Searle (503). On gneiss bird perches and over mosses, common. Clyde Inlet plants confirmed by Degelius.

253. *Physcia lithotodes* Nyl.—Clyde Inlet (354). On gneiss bird perches. Determined by Thomson. Apparently new to North America.

254. *Physcia muscigena* (Ach.) Nyl.—Arctic Bay (635); Pond Inlet (455, c. fr.); Clyde Inlet (247; 269, c. fr.); Cape Searle (418). Over mosses in moist habitats or on clay, very common and often fruiting abundantly.

255. *Physcia sciastra* (Ach.) DR.—Clyde Inlet (339). Over mosses and on gneiss bird perches, common. New to the Canadian Eastern Arctic.

LICHENES IMPERFECTI

256. *Thamnolia vermicularis* (Sw.) Ach.—Arctic Bay (356); Mitintatalik (T); Pond Inlet (D, P); Clyde (D, P); Clyde Inlet (234); Barnes Ice Cap (465); Cape Searle (426); Totnes Road (S); Pangnirtung (P); Frobisher Bay (386); Lake Harbour (P); Cape Dorset (P). On soil and in heaths everywhere, common but frequently very scattered. All plants collected by the author contain baecomycinic acid and react KOH + yellow.

257. *Crocynia neglecta* (Nyl.) Hue—Arctic Bay (D); Pond Inlet (647); Clyde (P); Clyde Inlet (793); Cape Searle (704). Over mosses and plant remains in shaded places, common and widespread.

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ADDENDUM

While this paper was in press, a number of additions and corrections were made to the list of species.

Coriscium viride (Ach.) Vain.—Clyde Inlet (974). On mosses in a Sphagnum 'bog.' Apparently new to the Canadian Eastern Arctic.

Acarospora sinopica was also found at Clyde Inlet (975) and Barnes Ice Cap (976), abundant on ferruginous schists.

Dr. Sten Ahlner kindly sent some corrections, as follows:

Acarospora chlorophana (594) is probably *A. oxytona* (Ach.) Mass. The author agrees with this revision.

Alectoria lanea was detected by Dr. Ahlner as a mixtum with *Cornicularia divergens* (225) from Clyde Inlet.

Crocynia neglecta is actually *C. membranacea* (Dicks.) Zahlbr.

Dr. Veli Räsänen generously examined a number of specimens also sent in an exchange and recorded the following observations:

Cetraria commixta (310) is redetermined as *C. polyschiza* (Nyl.) Jatta, a new addition to Baffin Island. At the same time packet 308, determined by the author as *C. hepatizon*, is actually *C. commixta* var. *agnata* (Nyl.) Dalla T. & S. No. 309, 330, 495 and 869 are in the author's opinion typical *C. hepatizon*.

Dr. Räsänen determined several species to forma:

Parmelia physodes (311) f. *sublugubris* Räs. *Lich. Fenn. Exs.* IV 1936. No. 187.

Rhizocarpon chionophilum (590) var. *decolorata* (Vain.) Räs.

Cetraria nigricans (221) var. *pallida* Räs. *Contr. Lich. N. Amer.* 1933.

Further discussions of *Cetraria nigricans* are given by Räsänen in a recent publication (Kuopion Luon. Ystävien Yhdys. julk. 2:1-53. 1952). Several new entities from the collection sent to him will be published.

The following species (in addition to *Nephroma arcticum*) were collected in the western part of Baffin Island:

At Lake Gillian on a sandy terrace: *Nephroma arcticum*. *Dactylina arctica* (5008090752), *Cladonia mitis* (5008090753).

At Bray Island on limestone gravel: *Cetraria delisei* (5008101496), *C. tilesii* (5008100497).

At the northeast side of the Ice Cap: *Cetraria crispa* (508110290), *Solorina bispora* (5008110266).

Addenda to North American Carices

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During the routine determinations of many thousands of collections of *Carex*, ranging from Panama north to Alaska, since the publication of K. K. Mackenzie's treatment of the Cariceae (North American Flora Vol. 18, Parts 1-7, 1931-35), extensions in range for several hundred species have come to light. It seems advisable to put these on record, and for the purpose of further bringing Mackenzie's monograph up to date to include notice of changes in nomenclature and new taxa.

New records in the present account represent states, provinces or countries for which no citations are given in Mackenzie's work and are based upon specimens identified by the writer. Relatively few records will be found here for the Pacific States since material from this area has been handled chiefly by the late J. W. Stacey and more recently by John Thomas Howell. Some of the records have already been published by the collectors either in miscellaneous notes scattered in periodicals or, in a few instances, in standard state floras, but it seemed best to include even the latter here for the sake of completeness.

Changes in nomenclature, new names and new species, subspecies, varieties and forms are indicated (in parentheses when a change in the status of a previously known taxon or material of a newly described one has not been studied by the writer) but transfers and changes in category have been included only for those studied and concurred in by the writer.

The material is arranged in the form of two lists, the first being in alphabetical order, where each name, in the case of new records or name-changes, is prefixed by the number employed by Mackenzie for the species. This number is followed by a letter in the case of a new subspecific categories or hybrids or by a fraction in the case of new species. The second list is arranged by states and countries as an aid to botanists working with local floristics who may be interested in the reports.

HERBARIUM ABBREVIATIONS

Al—University of Alberta, Edmonton
Ar—University of Arizona, Tucson
Bl—Bailey Hortorium, Ithaca, N. Y.
Br—Brooklyn Botanic Garden, Brooklyn, N. Y.
CA—California Academy of Sciences, San Francisco
Cal—University of California, Berkeley
Ch—Chicago Natural History Museum
Cr—Cranbrook Institute of Science, Bloomfield Hills, Mich.
CU—Catholic University, Washington, D. C.
D—C. C. Deam, Bluffton, Ind.
Dk—Duke University, Durham, N. C.
Dr—R. R. Dreisbach, Midland, Mich.
FS—U. S. Forest Service, Washington, D. C.
G—Gray Herbarium, Cambridge, Mass.

Ga—University of Georgia, Athens
H—F. J. Hermann, Beltsville, Md.
IS—Iowa State College, Ames
Kn—Kansas State College, Manhattan
Ky—University of Kentucky, Lexington
Md—University of Maryland, College Park
Mh—University of Michigan, Ann Arbor
Mo—Missouri Botanical Garden, St. Louis
MS—Michigan State College, East Lansing
NA—U. S. National Arboretum Herbarium, Beltsville, Md.
Nb—University of Nebraska, Lincoln
NC—University of North Carolina, Raleigh
ND—University of Notre Dame, Notre Dame, Ind.
NY—New York Botanical Garden, New York

P—Academy of Natural Sciences
of Philadelphia
PWR—Patuxent Wildlife Refuge,
Laurel, Md.
Tn—University of Tennessee, Knoxville

US—U. S. National Herbarium,
Washington, D. C.
Ws—University of Wisconsin, Madison
W Va—University of West Virginia,
Morgantown
Wy—University of Wyoming, Laramie

SPECIES LIST

- 366 *Carex ablata* Bailey—Montana (Granite Co., *Shanks & Iltis* 3947—NA).
421 *Carex aboriginum* M. E. Jones—Canada: British Columbia, West Vancouver,
J. W. Eastham 9512—H; NA).
288a (*Carex abscondita* var. *rostellata* Fern., *Rhodora* 44:386. 1942—Virginia & Ala-
bama.)
288b (X *Carex abscondiformis* Fern., *Rhodora* 44:387. 1942—*C. abscondita* x *laxi-*
culmis.)
451 [*Carex acuta* of authors, not L.] = *C. nigra* Reichard (cf. *Rhodora* 44:300.
1942).
498 *Carex acutiformis* Ehrh.—Indiana (St. Joseph Co., *P. E. Hebert*, May 26, 1951
—D; ND: *P. E. Hebert* 1494—H; NA; US).
437 $\frac{1}{4}$ (*Carex adelostema* Krecz., in Komarov, Fl. U.R.S.S. 3:275, 603. 1935; Mem.
Jard. Bot. Montreal 20:10. 1951—Ungava; Labr.)
330 *Carex aestivaliformis* Mack.—Virginia (Page Co., *F. J. Hermann* 10,752—NA).
331 *Carex aestivalis* M. A. Curtis—Kentucky (Harlan Co., *E. L. Braun* 259—NA);
Tennessee (Sevier Co., *J. K. Underwood* 121—H).
52 *Carex aggregata* Mack.—Virginia (Wythe Co., *F. J. Hermann* 10,627—Bl; H;
NA); Tennessee (Knox Co., *J. K. Underwood* 4605—NA); Michigan (Kala-
mazoo Co., *C. R. & F. N. Hanes* 1284—NA).
185 *Carex alata* Torr. & Gray—Missouri (Howell Co., *J. A. Steyermark* 5217—
NA).
214 [*Carex albicans* of authors, not Willd.] = *C. emmonsii* Dewey in Torr. Ann.
Lyc. N. Y. 3:411. 1836 (cf. *Rhodora* 40:330. 1938).
184 *Carex albolutescens* Schwein.—Kentucky (Bath Co., *M. E. Wharton* 2524—
NA); Michigan (Van Buren Co., *C. H. Kauffman*, July 25, 1910—Mh).
Carex aleutica Akiyama, Bot. Mag. (Tokyo) 47:69. 1933; Jour. Fac. Agric.
Hokkaido Imp. Univ. 36:105. 1934 = 450. *Carex hindsii* C. B. Clarke.
342 *Carex allegheniensis* Mack.—Kentucky (Wolfe Co., *McFarland & Lyle* 3303—
Ky; NA); Georgia (De Kalb Co., *H. Eggert*, May 21, 1897—NA).
88 $\frac{1}{2}$ (*Carex amblyorhyncha* Krecz., in Komarov, Fl. U.R.S.S. 3:595. 1935; Acta
Arctica 5:17. 1952.—Canada (Mackenzie District; Keewatin; Manitoba; On-
tario).)
882 $\frac{1}{2}$ a (*Carex amblyorhyncha* ssp. *pseudolagopina* (T. Sørensen) Böcher, Acta Arctica
5:25. 1952.—Canada (Franklin District; Mackenzie District; Keewatin);
Greenland.)
117 *Carex angustior* Mack.—Virginia (Augusta Co., *H. A. Allard* 145—US); Ten-
nessee (Johnson Co., *J. K. Underwood* 768—H). The record for the District
of Columbia in N. Amer. Flora 18:113 is erroneous, being based upon a form
of *C. howei* Mack. with abnormally narrow perigynia.
117a (*Carex angustior* var. *gracilentia* Clausen & Wahl, *Rhodora* 41:30. 1939—Penn-
sylvania.)
317 *Carex anisostachys* Liebm.—Vera Cruz, Mexico (*A. J. Sharp* 44,758—NA).
62 *Carex annectens* Bickn.—Kentucky (Campbell Co., *E. L. Braun* 3980—NA);
Arkansas (Drew Co., *D. Demaree* 14,656—H); Michigan (Macomb Co., *A.*
J. Peters, Sept. 2, 1893—Mh).
457 *Carex aquatilis* Wahl.—Michigan (Keweenaw Co., *C. A. Brown* 3603—Mh);
Arizona (Apache Co., *W. S. Phillips* 3247—CA).
457a (*Carex aquatilis* var. *plumbeophila* L. Kelso, Biol. Leaf. 51:2. 1950—Colorado.)
3 $\frac{1}{2}$ (*Carex arctogena* H. Smith, Acta Phytog. 13:191. 1940—Labrador, New Hamp-
shire, Argentina).
3 $\frac{1}{2}$ (*Carex arctogena* H. Smith—Nevada (Washoe Co., *W. A. Archer* 6459—NA).
21 *Carex arenaria* L.—Maryland (*B. Sollers*, May 1891—US); North Carolina
(New Hanover Co., *R. K. Godfrey* 51,166—Dk; NA).

- 194 *Carex argyrantha* Tuckerm.—North Carolina (Ashe Co., *Godfrey & Fox* 50,231—NC).
- 203 *Carex arsenii* Kükenth.—Coahuila, Mexico (*L. R. Stanford et al.* 35—CA; NA).
- 213 *Carex artictecta* Mack.—North Carolina (Polk Co., *O. M. Freeman* 5186—NA); Georgia (De Kalb Co., *D. E. Eyles* 1018—NA); Nebraska (Richardson Co., *H. C. Reynolds* 3011—NA).
- 213a *Carex artictecta* var. *subtilirostris* Hermann, *Rhodora* 40:79. 1938—Indiana (Vermillion Co., *C. C. Deam* 54,764—D).
- 502 *Carex atherodes* Spreng.—Michigan (Ingham Co., *H. T. Darlington* 2—MS); Nevada (Elko Co., *S. Watson* 1264—US).
- 195 *Carex athrostachya* Olney—Arizona (Coconino Co., *Kearney & Peebles* 13,709—US).
- 303½ *Carex atractodes* Hermann, *Jour. Wash. Acad. Sci.* 40:283. 1950—Mexico (Chiapas, *A. J. Sharp* 45,450—NA; Tn).
- 433 *Carex atrata* L.—Utah (Duchesne Co., *F. J. Hermann* 4965—CA; G; H).
- 364 *Carex atrofusca* Schkuhr—Ontario (James Bay, *R. H. Smith* 25, in part—H; NA).
- 364a (*Carex atrofusca* var. *decolorata* Porsild, *Sargentia* 4:20. 1943—Canada (Mackenzie District).)
- 364b (*Carex atrofusca* var. *nortoniana* Boivin, *Nat. Canad.* 75:208. 1948.—Alaska.)
- 272 *Carex aurea* Nutt.—Indiana (Lake Co., *E. J. Hill* 26—Ch); Arizona (Coconino Co., *R. Collom* 1521—US).
- 283 *Carex austrocarolina* Bailey—Georgia (Dade Co., *F. J. Hermann* 10,180—G; NA; NY).
- 58 [*Carex autumnalis* Mack., not Ohwi] = *C. marianensis* Stacey, *Leaf. West. Bot.* 2:31. 1937.
- 201 *Carex backii* Boott—Arkansas (Polk Co., *N. C. Fassett* 20,918—Ws).
- 527 *Carex baileyi* Britt.—Virginia (Giles Co., *F. J. Hermann* 10,690—Bl; G; H; NA; NY); Kentucky (Bell Co., *E. L. Braun* 1563—NA); Tennessee (Sullivan Co., *J. K. Underwood* 87—H).
- 391½ (*Carex ballsii* Nelm., *Kew Bull.* 1940:134—Vera Cruz, Mexico.)
- 265½ (*Carex bartlettii* O'Neill, *Carnegie Inst. Wash. Publ.* 522:255. 1940—British Honduras.)
- 78½ (*Carex bayardi* Fern., *Rhodora* 44:71. 1942—Virginia (*C. crus-corvi* var. *virginiana* Fern.; *Rhodora* 39:393. 1937).)
- 429 *Carex bella* Bailey—South Dakota (Lawrence Co., *A. S. Hitchcock*, June 24, 1914; Mexico (Nuevo Leon, *R. A. Schneider* 960—NA).
- 174 *Carex bicknellii* Britt.—Michigan (St. Joseph Co., *C. F. Wheeler*, June 8, 1893—MS).
- 278 *Carex biltmoreana* Mack.—South Carolina (Oconee Co., *W. T. Batson, Jr.*, June 6, 1950—H).
- 63 [*Carex brachyglossa* Mack.] = *C. annectens* var. *xanthocarpa* (Bickn.) Wieg., *Rhodora* 24:74. 1922.
- 167 *Carex brevior* (Dewey) Mack.—Virginia (Rockbridge Co., *O. M. Freeman*, May 29, 1939—NA); Kentucky (Fayette Co., *F. T. McFarland* 4410—Ky; NA); West Virginia (Jefferson Co., *J. L. Poland*, May 28, 1939—W Va); Arizona (Navajo Co., *L. M. Pultz* 1678-A—NA).
- 228 *Carex brevipes* W. Boott—Idaho (Idaho Co., *R. J. Davis* 3492—NA); Nevada (Mineral Co., *W. A. Archer* 6778—NA).
- 120 *Carex bromoides* Schkuhr—West Virginia (Preston Co., *H. A. Davis* 4072—W Va).
- 93 *Carex brunnescens* (Pers.) Poir.—Georgia (Floyd Co., *H. C. Jones* 508—NA); Utah (Duchesne Co., *F. J. Hermann* 5183—H).
- 521 *Carex bullata* Schkuhr—Connecticut (Tolland Co., *M. T. Travis* 2279—NA).
- 379 *Carex bushii* Mack.—Virginia (Culpeper Co., *H. A. Allard* 1451—US).
- 437a (*Carex buxbaumii* var. *anticostensis* Raymond, *Nat. Canad.* 77:58. 1950—Quebec).
- 437b (*Carex buxbaumii* f. *pedunculata* Raymond, *Nat. Canad.* 77:58. 1950—Quebec.)
- 444a (*Carex campylocarpa* subsp. *affinis* Maguire & Holmgren, *Leaf. West. Bot.* 14:262. 1946—Utah.)

- 96a *Carex canescens* var. *disjuncta* Fern.—West Virginia (Tucker Co., *H. A. Allard* 6855—US).
- 347a (*Carex capillaris* var. *porcildiana* Polunin, Jour. Linn. Soc. 52:373. 1943—Kewatin, Greenland, Iceland.)
- 285 *Carex careyana* Torr.—Kentucky (Fayette Co., *F. T. McFarland* 4228—Ky; NA); Alabama (Marshall Co., *R. M. Harper* 3349—US); Wisconsin (Vernon Co. (?), *J. B. Marks* 5—Ws).
- 378 *Carex caroliniana* Schwein.—Kentucky (Jefferson Co., *M. E. Wharton* 4459a—NA).
- 119 *Carex cephalantha* (Bailey) Bickn.—Virginia (Augusta Co., *E. P. Killip* 32,576—US); Michigan (Chippewa Co., *C. K. Dodge*, June 14, 1914—Mh).
- 33 *Carex cephalophora* Muhl.—Nebraska (Richardson Co., *H. C. Reynolds* 1261—NA).
- 432a (*Carex chalciolepis* var. *larimerana* L. Kelso, Biol. Leaflet 30:2. 1945—Colo.)
- 282 *Carex chapmanii* Steud.—North Carolina (Craves Co., *H. L. Blomquist* 15,106—Dk; H).
- 349 *Carex cherokeeensis* Schwein.—Tennessee (Sevier Co., *H. K. Svenson* 7055—NA); South Carolina (Pickens Co., *W. M. Scott*, June 14, 1939—H).
- 73 *Carex chihuahuensis* Mack.—United States: Arizona (Graham Co., *Maguire & Maguire* 11,483—NY).
- 441 *Carex chimaphila* Holm.—Montana (Granite Co., *H. H. Illis* 3946—NA).
- 392 *Carex chordalis* Liebm.—Chiapas, Mexico (*A. J. Sharp* 45,437—NA; Tn); Jalisco, Mexico (*R. McVaugh* 10,062—H; Mh).
- 220 *Carex communis* Bailey—Missouri (Taney Co., *J. A. Steyermark* 10,116—NA).
- 495 *Carex comosa* Boott.—Texas (Wood Co., *C. L. & A. A. Lundell* 9488—M; NA).
- 244 *Carex concinna* R. Br.—Alaska (Chitina, *H. J. Lutz* 1054—FS; NA).
- 438 [*Carex concolor* Mack., not R. Br.] = *C. bigelovii* Torr. in Schwein. Ann. Lyc. N. Y. 1:67. 1824. (cf. *Rhodora* 44:298. 1942).
- 80 *Carex conjuncta* Boott.—Tennessee (Hamilton Co., *R. S. Walker*, May 5, 1952—NA); Alabama (Limestone Co., *R. M. Harper* 3223—US); Nebraska (Richardson Co., *H. C. Reynolds* 1490—NA).
- 245 *Carex conoidea* Schkuhr—Missouri (Callaway Co., *W. B. Drew* 104—NA).
- 155 $\frac{1}{2}$ (*Carex constanceana* Stacey, Leaflet West. Bot. 2:123. 1938—Washington.)
- 312 $\frac{1}{2}$ (*Carex corrugata* Fern., *Rhodora* 44:76. 1942—Alabama; Virginia.)
- 393 *Carex cortesii* Liebm.—Central America: Costa Rica (Prov. de Cartago, *Holm & Illis* 563—Mo).
- 299 *Carex crebriflora* Wieg.—Georgia (Burke Co., *Pyron & McVaugh* 2483—NA); Alabama (Sumter Co., *R. M. Harper* 3362—US).
- 475a. (*Carex crinita* var. *brevicrinis* Fern., *Rhodora* 48:54. 1946—North Carolina to Texas, New England, Kentucky and Missouri.)
- 188 *Carex cristatella* Britt.—Alberta (Ft. Saskatchewan, *G. H. Turner* 2621—NA).
- 181 *Carex cumulata* Mack.—Indiana (Newton Co., *M. McKee* 1743—H); Illinois (Kankakee Co., *R. A. Schneider* 1654—NA); Manitoba (Winnipeg, *J. Macoun* 98,580—CU).
- 181a (*Carex cumulata* f. *soluta* Fern., *Rhodora* 44:285. 1942—Nova Scotia.)
- 240 $\frac{1}{2}$ *Carex curatorium* Stacey, Leaflet West. Bot. 2:13. 1937—Arizona (Coconino Co., *Eastwood & Howell* 1100—CA).
- 13 $\frac{1}{2}$ (*Carex danaensis* Stacey, Leaflet West. Bot. 2:166. 1939—Calif.)
- 329 *Carex davisii* Schwein. & Torr.—Tennessee (Sevier Co., *H. K. Svenson* 7055—US); Michigan (Berrien Co., *C. Billington*, July 29, 1919—Cr); Nebraska (Richardson Co., *H. C. Reynolds* 1447—NA).
- 399a X *Carex deamii* Hermann, *Rhodora* 40:81. 1938—*C. shortiana* x *typhina*.
- 340a (*Carex debilis* var. *intercurva* Fern., *Rhodora* 44:307. 1942—Virginia, North Carolina.)
- 66 *Carex decomposita* Muhl.—Virginia (Fairfax Co., *Maxon & Standley* 226—US).

166 $\frac{1}{2}$ *Carex dichlii* M. E. Jones, sp. nov. (Ovales)

Caespitosa e rhizomatibus crassis; culmi rigidi 3-4.5 dm. alti, foliis fere bis longiores basi obtuse sub capitulis acute triangulares; folia frondosa 3-5, laminis 4-15 cm. longis, 1.5-4 mm. latis, canaliculatis in apicem scabridulum attenuatis; vaginis artis infinis fibrose

dissolutis; spicae 5-7 gynaeandreae sessiles in capitulum terminale 15-20 mm. longum, 10-14 mm. latum confertae bracteae squamiformibus infima fere frondosa inflorescentiam superanti; squamae oblongo-lanceolatae castaneae 4 mm. longae; perigynia plano-convexa, anguste ovato-lanceolata, 4 mm. longa, 1.6-1.9 mm. lata, coriacea, straminea, ventre enervia vel ad basim vix 5-7-nervia dorso 5-9-nervia, anguste alata, superne marginibus serrulatis in rostrum 1-1.5 mm. longum apice bidentulatum attenuata; achaenia lenticulari-oblonga, 1.7 mm. longa, 1 mm. lata, cinerea irregulariter purpureo-punctata.

Cespitose from stout, brown rootstocks; culms 3-4.5 dm. high, stiff, almost twice the length of the leaves, coarsely striate, obtusely triangular and smooth below, somewhat acutely angled and more or less scabridulous below the heads; leaves with well-developed blades 3 to 5 to a fertile culm, chiefly on the lower third of the culm, the blades conspicuously canaliculate, erect, 4-15 cm. long, 1.5-4 mm. wide, the long-attenuate, scabridulous apex more or less trigonous, the sheaths tight, ventrally white-hyaline, thin, generally ruptured and sometimes brown-stained in age, concave at the mouth, becoming strongly fibrillose with age, the ligule slightly wider than long; spikes 5-7, gynaeandrous, sessile, aggregated into an ovoid to broadly oblong head 15-20 mm. long, 10-14 mm. wide, the perigynia 9-20, ascending to erect-appressed; bracts prolonged-squamiform, long attenuate, the lowermost sometimes almost leaflike and somewhat exceeding to twice the length of the head; scales oblong-lanceolate, acute to acuminate, chestnut-brown, narrowly hyaline-margined, prominently one-nerved, carinate and hyaline along the midrib, 4 mm. long, not concealing the perigynia; perigynia plano-convex, narrowly ovate-lanceolate, 4 mm. long, 1.6-1.9 mm. wide, thick-coriaceous, stramineous, nerveless ventrally or faintly 5-7-nerved toward the base, dorsally 5-9-nerved or ribbed, very slightly distended over the achene, narrowly wing-margined, narrowed to the rounded, sessile or minutely substipitate spongy base, the body serrulate on the margins above, tapering into a dark, flat, shallowly bidentate beak 1-1.5 mm. long; achenes lenticular, oblong, 1.7 mm. long, 1 mm. wide, glossy, gray flecked with dark red; style slender, jointed 0.4 mm. above the achene, deciduous; stigmas two.

Mexico: CHIHUAHUA—Meadow Valley, alt. 7000 ft., Sierra Madre Mts., *Marcus E. Jones*, Sept. 17, 1903 (*Type*—Pomona College Herbarium No. 81199). In habit, congested inflorescence and dark scales suggestive of *Carex multicostata* Mack. The perigynia, however, are nearest those of *Carex molesta* Mack., from which they differ in being more coriaceous and more narrowly winged, especially toward the base.

- 289a (*Carex digitalis* var. *asymetrica* Fern., *Rhodora* 43:544. 1941—Virginia to Florida.)
 289b (*Carex digitalis* var. *macropoda* Fern., *Rhodora* 40:400. 1938—Maryland to Louisiana and Indiana.)
 351 $\frac{1}{2}$ *Carex distans* L.—United States: Maryland (Charles Co., *Hotchkiss & Uhler* 7218—H; NA; US).
 362 $\frac{1}{2}$ (*Carex distichiflora* Boivin, *Nat. Canad.* 75:206. 1948—Canada: Northwest Terr.)
 228 $\frac{1}{2}$ (*Carex diversistylis* A. W. Roach, *Madroño* 11:277. 1952—Oregon.)
 19 $\frac{1}{2}$ *Carex divisa* Huds.—United States: Maryland (Charles Co., *S. F. Blake* 11,656—NA); North Carolina (Hanover Co., *H. L. Blomquist* 15,064—Dk; NA).
 254 *Carex drummondiana* Dewey—Wyoming (Albany Co., *J. F. & M. S. Reed* 2471 NA; Wy); Utah (Duchesne Co., *F. J. Hermann* 4999—H; Mo).
 16 $\frac{1}{2}$ (*Carex ditylii* O'Neill & Duman, *Rhodora* 43:413. 1941—Manitoba.)
 149 $\frac{1}{2}$ (*Carex eastwoodiana* Stacey, *Leaff. West. Bot.* 2:121. 1938—Montana, Utah and Wyoming to Oregon and Washington.)
 126 *Carex ebenea* Rydb.—Montana (Madison Co., *Lemon & Evanko* PL-120—FS).
 259 *Carex eburnea* Boott—West Virginia (Pendleton Co., *H. A. Allard* 3606—US); Alabama (Bibb Co., *R. M. Harper* 3552—US); Arkansas (Stone Co., *R. A. Reed* GL-37—FS; NA); North Dakota (Belings Co., *E. C. Moran*, July 26, 1939—NA).
 424 1/3 (*Carex elbertana* L. Kelso, *Biol. Leaff.* 31:3. 1945—Colorado.)
 2 $\frac{1}{2}$ (*Carex elynaeformis* A. E. Porsild, *Sargentia* 4:17. 1943—Colorado and Canada (Mackenzie Distr.).)
 206 *Carex elynoides* Holm—Nevada (Elko Co., *S. Watson* 1220—US).
 214 *Carex emmonsii* Dewey—Kentucky (Elliot Co., *E. L. Braun* 1220—NA); Georgia (Screven Co., *D. E. Eyles* 6880—NA).
 464 *Carex emoryi* Dewey—West Virginia (Raleigh Co., *J. P. Tosh*, May 9, 1941—US); Arkansas (Hot Springs Co., *D. Demaree* 14,386—NY).

- 433 $\frac{1}{2}$ (*Carex enanderi* Hultén, Fl. Alaska & Yukon 2:355. 1942—Alaska.)
- 427 *Carex epapillosa* Mack.—Montana (Madison Co., P. C. Lemon PL-162—FS; NA).
- 222 $\frac{1}{2}$ (*Carex erxlebeniana* L. Kelso, Biol. Leaflet. 51:1. 1950—Colorado.)
- 424 $\frac{1}{2}$ (*Carex estesiana* L. Kelso, Biol. Leaflet. 30:3. 1945—Colorado.)
- 100 *Carex exilis* Dewey—North Carolina (Moore Co., Godfrey, Fox & Woods 49,152—NA).
- 352 *Carex extensa* Gooden.—Maryland (Somerset Co., F. M. Uhler, July 3, 1948—H; NA; US).
- 165 *Carex festucacea* Schkuhr—Michigan (Monroe Co., O. A. Farwell 8004—Mh); Nebraska (Richardson Co., H. C. Reynolds 1517—NA).
- 205 *Carex filifolia* Nutt.—Arizona (Apache Co., Gould & Phillips 4877—US); California (Inyo Co., J. T. Howell, July 16, 1946—CA); Alberta (Pincher Creek, E. H. Moss 161—Al; NA).
- 217 [*Carex floridana* Schwein.] = *C. nigromarginata* var. *floridana* (Schwein.) Kienkenthal in Engler, Pflanzenreich 40(20):444. 1909.
- 194 [*Carex foenea* of authors, not Willd.] = *C. argyrantha* Tuckerm. in Dewey, Amer. Journ. Sci. II, 29:346. 1860 (cf. *Rhodora* 40:326. 1938).
- 22 *Carex foenea* Willd. (*C. siccata* Dewey)—British Columbia (Vanderhoof, J. W. Eastham 11,748—NA).
- 507 *Carex frankii* Kunth—Michigan (Monroe Co., P. E. Hebert, July 6, 1931—ND); Nebraska (Richardson Co., H. C. Reynolds 1538—NA).
- 362a (*Carex franklinii* var. *nicholsonis* Boivin, Nat. Canad. 75:207. 1948—Canada (Mackenzie District).)
- 351 [*Carex fulvescens* Mack.] = *C. hostiana* DC. Cat. Hort. Monsp. 88. 1813; and 351a. *C. hostiana* var. *laurentiana* Fern. & Wieg. *Rhodora* 26:122. 1924.
- 271 $\frac{1}{2}$ *Carex garberi* Fern., *Rhodora* 37:253. 1935. (*C. hassei* Mack. in part, not Bailey)—Northern United States and Canada.
- 271 $\frac{1}{2}$ *Carex garberi* Fern.—North Dakota (Burke Co., N. Hotchkiss 6714—NA); Nevada (White Pine Co., Ripley & Barneby 6286—H).
- 271 $\frac{1}{2}$ a *Carex garberi* var. *bifaria* Fern., *Rhodora* 37:255. 1935—Quebec; New Brunswick; Maine; Alberta; British Columbia.
- 271 $\frac{1}{2}$ a *Carex garberi* var. *bifara* Fern.—Montana (Gallatin Co., J. C. Whitman 1698—FS; H); Saskatchewan (A. J. Breitung, July 7, 1936—H); Alaska (R. F. Taylor 54—NA).
- 258 *Carex geyeri* Boott—Pennsylvania (Centre Co., Clausen & Wahl 2524—Introduced?).
- 533 *Carex gigantea* Rudge—Maryland (Worcester Co., J. B. S. Norton 1951—Md).
- 403 *Carex glaucescens* Ell.—Texas (Polk Co., B. C. Tharp 43,282—Bl).
- 422 *Carex gmelini* Hook. & Arn.—Aleutian Islands (C. L. York 44,392—H; Mo).
- 302 *Carex gracilescens* Steud.—Kentucky (Johnson Co., McFarland & Shacklette 3394—Ky; NA).
- 49 *Carex gravida* Bailey—Kentucky (F. T. McFarland 4409—Ky; NA); Colorado (Las Animas Co., C. M. Rogers 4516—Wayne Univ. Herb.). A report for Princess Anne Co., Virginia (F. E. Egler: Check List of the Ferns and Flowering Plants of the Seashore State Park, Cape Henry, Va., page 24—N. Y. State College of Forestry, Syracuse, 1942) is based upon an erroneously identified specimen of *Carex muhlenbergii* Schkuhr.
- 50 *Carex gravida* var. *luelliana* (Mack.) Hermann—Indiana (Vigo Co., C. C. Deam 53,768—D); Nebraska (Richardson Co., H. C. Reynolds 1639—NA); Colorado (Yuma Co., J. A. Ewan 12,783—NA).
- 313 [*Carex grisea* of authors, not Wahl.] = *C. amphibola* var. *turgida* Fern., *Rhodora* 44:311. 1942.
- 442 *Carex gymnoclada* Holm—Canada: British Columbia (Kalso, J. W. Eastham, July 11, 1941—NA).
- 427 $\frac{1}{2}$ (*Carex hagiania* L. Kelso, Biol. Leaflet. 30:2. 1945—Colorado.)
- 437 1/3 (*Carex hartmani* Cajander, Ann. Bot. Soc. Zool.—Bot. Fenn. Vanamo 5:23. 1935; Canad. Jour. Research, sec. C, 28:418. 1950—Anticosti Island.)
- 271 *Carex hassei* Bailey—Colorado (Las Animas Co., J. A. Ewan 13,245—NA); Arizona (Coconino Co., Eastwood & Howell 7092—US).
- 127 *Carex haydeniana* Olney—Arizona (Coconino Co., R. Collom, in 1943—US).

- 463 *Carex haydenii* Dewey—Michigan (Midland Co., *R. R. Dreisbach* 8056—Dr.).
 222 *Carex heliophila* Mack.—Indiana (Tippecanoe Co., *C. C. Deam*, June 3, 1924—D); Wisconsin (Dane Co., *F. J. Hermann* 8754—Ws.).
 2 *Carex hepburnii* Boott—Nevada (Elko Co., *Mills & Beach* 1559—Cal; NA).
 377 *Carex hirsutella* Mack.—Georgia (Heard Co., *Pyron & McVaugh* 2832—NA); Kansas (Cherokee Co., *A. S. Hitchcock* 871—Kn).
 386 *Carex hirta* L.—Michigan (Allegan Co., *O. A. Farwell* 6584—H; Mh).
 309 *Carex hitchcockiana* Dewey—Nebraska (Nemaha Co., *W. L. Tolstead* 41,329—NA).
 106 *Carex howei* Mack.—North Carolina (Polk Co., *O. M. Freeman* 51,278—NA); Indiana (Porter Co., *M. W. Lyon, Jr.*, June 17, 1923—ND).
 324 1/3 (*Carex huehueteca* Standl. & Steyerl., *Field Mus. Pub. Bot.* 23:195. 1947—Guatemala.)
 264 *Carex humboldtiana* Steud.—Guerrero, Mexico (*A. J. Sharp* 441,386—NA).
 500 *Carex hyalinolepis* Steud.—Maryland (Calvert Co., *Uhler, W. H. & L. S. Stickel*—PWR).
 136 *Carex illota* Bailey—Utah (Duchesne Co., *F. J. Hermann* 4954—H; Mo); Montana (Granite Co., *H. H. Illis* 3949—NA).
 108 *Carex incompta* Bickn.—West Virginia (Hardy Co., *H. A. Allard* 6757—US).
 14 [*Carex incurva* Lightf.] = *C. maritima* Gunner, *Fl. Norweg.* 2:131. 1772 (cf. *Rhodora* 35:396. 1933).
 14a [*Carex incurva* var. *inflata* Simmons] = *C. maritima* f. *inflata* (Simmons) Polunin, *Bull. Nat. Mus. Canada* 92:110. 1940.
 14b [*Carex incurva* var. *setina* Christ] = *C. maritima* var. *setina* (Christ) Fern., *Rhodora* 35:397. 1933.
 469 1/2 (*Carex interimus* Maguire, *Brittonia* 5:200. 1944—Utah.)
 105a *Carex interior* subsp. *charlestonensis* Clokey, *Bull. S. Calif. Acad. Sci.* 38:1. 1939—Nevada.
 105b *Carex interior* f. *keweenawensis* (Hermann) Fern. *Rhodora* 44:284. 1942—Mich.
 529 *Carex intumescens* Rudge—Kentucky (McCreary Co., *E. L. Braun* 4232—NA).
 529b (*Carex intumescens* var. *fernaldii* f. *ventricosa* Fern., *Rhodora* 44:321. 1942—Newfoundland to North Carolina.)
 11 1/2 (*Carex jacobipeteri* Hultén, *Fl. Alaska & Yukon* 2:300. 1942—Alaska.)
 200 *Carex jamesii* Schwein.—Nebraska (Richardson Co., *H. C. Reynolds* 1450—NA).
 70 *Carex jonesii* Bailey—Colorado (Garfield Co., *F. J. Hermann* 5589—CA; H).
 401 *Carex joorii* Bailey—North Carolina (Sampson Co., *Fox & Godfrey* 2150—Dk; NA); Alabama (Tuscaloosa Co., *Svenson & Harper* 9434—NA).
 529c (X *Carex joseph-schmittii* Raymond, *Canad. Jour. Research*, 28, sec. C:248. 1950—*C. intumescens* var. *fernaldii* x *retrorsa*.)
 310 *Carex katahdinensis* Fern.—Minnesota (St. Louis Co., *Olga Lakela* 12562—Univ. of Minnesota, Duluth Branch; cf. *Rhodora* 54:163. 1952).
 449 *Carex kelloggii* W. Boott—Arizona (Coconino Co., *J. F. Arnold* 33—Ar); Nevada (Elko Co., *P. Train* 851—CA; H; NA).
 81 *Carex kobomugi* Ohwi, *Mem. Coll. Sc. Kyoto Imp. Univ. Ser. B.* (3):281. 1930—New Jersey (Ocean Co., *F. J. Hermann* 3603—H; Mh; Mo; P; US); Virginia (Princess Anne Co., *E. H. Walker* 1208—US).
 450 1/2 (*Carex kokrinensis* A. E. Porsild, *Rhodora* 41:206. 1939—Alaska.)
 499 *Carex lacustris* Willd.—Saskatchewan (Prince Albert, *W. P. Fraser* 24—H); Nebraska (Lincoln Co., *W. Kiener* 24538—NA).
 501 *Carex laeviconica* Dewey—Wisconsin (Pierce Co., *Uhler & Hotchkiss* 23—PWR).
 169 1/2 *Carex lagunensis* M. E. Jones, *Extracts from Contr. West. Bot.* 18:26. 1933—Baja California.
 14 1/2 (*Carex langeana* Fern., *Rhodora* 35:217. 1933—Newfoundland.)
 348a (*Carex lanuginosa* var. *oriens* Raymond, *Nat. Canad.* 77:59. 1950—Quebec.)
 385 [*Carex lasiocarpa* of authors, not Ehrh.] = *C. lasiocarpa* Ehrh., var. *americana* Fern., *Rhodora* 44:304. 1942.
 385 *Carex lasiocarpa* var. *americana* Fern.—Oregon (Klamath Co., *P. B. Kennedy*, July 31, 1926—NA).
 291 *Carex laziculmis* var. *copulata* (Bailey) Fern.—Illinois (Jo Daviess Co., *F. J. Hermann* 8841—NY).

- 296a *Carex laxiflora* var. *serrulata* Hermann, *Rhodora* 40:80. 1938—Indiana, Pennsylvania.
- 296a *Carex laxiflora* var. *serrulata* Hermann—Pennsylvania (Bucks Co., *F. J. Hermann* 3443—Bl); Kentucky (Magoffin Co., *McFarland & Shacklette*, May 21, 1939—Ky; NA); Tennessee (Cannon Co., *H. K. Svenson* 9267—NA); Indiana (De Kalb Co., *C. C. Deam* 3032—D).
- 34 *Carex leavenworthii* Dewey—Michigan (Kalamazoo Co., *C. R. & F. N. Hanes* 3557—Mh); Nebraska (Richardson Co., *H. C. Reynolds* 3362—NA).
- 447 *Carex lenticularis* Michx.—British Columbia (Kingsgate, *W. A. Weber* 2237—NA).
- 363 1/3 (*Carex lepageana* Raymond, *Canad. Field Nat.* 66:101. 1952—Alaska.)
- 359 [*Carex lepidocarpa* of Amer. authors, not Tausch.] = *C. lepidocarpa* Tausch. var. *nemesiana* Raymond, *Bull. Soc. Bot. France* 99:194. 1952.
- 150 *Carex leporinella* Mack.—Nevada (Mineral Co., *W. A. Archer* 7103—NA).
- 298 *Carex leptoneuria* Fern.—West Virginia (Tucker Co., *H. A. Allard* 6895—NA); Kentucky (Harlan Co., *E. L. Braun*—NA).
- 219 *Carex leucodonta* Holm—Tamaulipas, Mexico (*Stanford, Lauber & Taylor* 2651—US).
- 407 *Carex limosa* L.—Nevada (Elko Co., *R. Hermansen* 100H—H; FS).
- 457b (*X Carex limula* Fries; Raymond, *Bull. Soc. France* 99:195. 1952—*C. aquatilis* x *bigelovii*).
- 273a *Carex livida* var. *grayana* Fern., *Rhodora* 28:8. 1926—Northern United States and Canada.
- 273a *Carex livida* var. *grayana* Fern.—Aleutian Islands (Attu Isl., *G. W. Soule* 493—Mo; NA).
- 273b *Carex livida* var. *rufoaeformis* Fern., *Rhodora* 28:8. 1926—Newfoundland.
- 491 *Carex lonchocarpa* Willd.—North Carolina (Harnett Co., *D. S. Correll* 9008—NA).
- 318 *Carex longicaulis* Bock.—Oaxaca, Mexico (*A. J. Sharp* 45,901—NA); Puebla, Mexico (*A. J. Sharp* 441,025—NA); Vera Cruz, Mexico (*A. J. Sharp* 44,760 NA).
- 182 *Carex longii* Mack.—Michigan (Kalamazoo Co., *F. J. Hermann* 9007—G; H; Mh; NY).
- 203 1/2 *Carex longissima* M. E. Jones, *Extracts from Contr. West. Bot.* 18:26. 1933—Baja California.
- 50 [*Carex lunelliana* Mack.] = *C. gravida* var. *lunelliana* (Mack.) Hermann, *Amer. Midl. Nat.* 17:855. 1936.
- 477a (*Carex lyngbyei* subsp. *cryptocarpa* (C. A. Mey.) Hultén, var. *gigas* Hultén, *Fl. Aleutian Is.* 113, 1937—Aleutian Is.)
- 324 1/2 (*Carex mackenziana* Weatherby, *Contr. Gray Herb.* 114:36. 1936—Mexico (Nuevo Leon).
- 92 *Carex mackenziei* Krecz.—Ontario (Eckwan River, *R. H. Smith* 162—H; NA); Alaska (Sitkine Flats, *L. J. Palmer*, July 30, 1942—PWR).
- 129 *Carex macloviana* Urv.—Alberta (Jasper Nat'l. Park, *W. P. Fraser* 16—H; NA).
- 81 [*Carex macrocephala* of authors] includes 81. *Carex kobomugi* Ohwi (Japan; eastern coast of U. S.) and 81 1/2. *Carex macrocephala* Willd. (Japan; western coast of U. S.).
- 363 1/2 (*Carex magnursiana* Raymond, *Canad. Field Nat.* 66:100. 1952—N. W. Territories.)
- 14 *Carex maritima* Gunner (*C. incurva* of authors)—Alberta (*G. H. Turner* 2248—NA).
- 276 *Carex meadii* Dewey—Arizona (Coconino Co., *A. Eastwood* 6004—CA).
- 518 1/2 (*Carex melozitensis* A. E. Porsild, *Rhodora* 41:209. 1939—Alaska.)
- 37 *Carex mesochorea* Mack.—West Virginia (Wayne Co., *L. Plymale* 346—US); Indiana (Owen Co., *R. C. Friesner* 5554—H).
- 307 *Carex microdonta* Torr. & Hook.—Missouri (Osage Co., *J. A. Steyermark* 27,682—Mo); Kansas (Chautauqua Co., *A. S. Hitchcock* 1021—Kn).
- 125 *Carex microptera* Mack.—Arizona (Coconino Co., *R. Collom* 1590—US); British Columbia (Nelson, *J. W. Eastham*, July 9, 1941—NA).

- 510a (*Carex miliaris* var. *ungavensis* Raymond, Bull. Bot. Soc. France 99:196. 1952—Ungava.)
- 100a (*X C. minganinsularum* Raymond, Bull. Soc. Bot. France 99:197. 1952—*C. exilis* x *sterilis*.)
- 363 *Carex misandra* R. Br.—Utah (Duchesne Co., *F. J. Hermann* 5027—H; Mo).
- 166 *Carex molesta* Mack.—Pennsylvania (Allegheny Co., *J. Bright* 777—H); Virginia (Madison Co., *F. R. Fosberg* 15,313—US); Texas (Bell Co., *S. E. Wolff* 2899—US); Colorado (Las Animas Co., *C. M. Rogers* 5022—Wayne Univ.)
- 416 [*Carex montanensis* Bailey] = *C. podocarpa* R. Br. (cf. A. E. Porsild, Nat. Mus. Canada Bull. 121:118. 1951).
- 437½ (*Carex morrisseyi* A. E. Porsild, *Sargentia* 4:21. 1943—Labrador to Mackenzie Distr.)
- 257 *Carex multicaulis* Bailey—Nevada (Elko Co., *P. Train* 723—CA: H; NA).
- 262½ *Carex micrulatula* Hermann, Field & Lab. 17:132. 1949—Texas (Culberson Co., *Moore & Steyermark* 3625—NA; Brewster Co., *Ferris & Duncan* 2852—CA).
- 189 *Carex muskingumensis* Schwein.—Arkansas (Crittenden Co., *D. Demaree* 12,959—H).
- 457c (*X Carex nearctica* Raymond, Bull. Soc. Bot. France 99:195. 1952—*C. aquatilis* var. *stans* x *bigelovii*).
- 424 *Carex nelsonii* Mack.—Utah (Duchesne Co., *F. J. Hermann* 5043—H; Mo).
- 71 *Carex neuophora* Mack.—Colorado (Garfield Co., *F. J. Hermann* 5444—G; H; Mo); Nevada (Elko Co., *W. B. Sargent* 28—FS).
- 217 *Carex nigromarginata* var. *floridana* (Schwein.) Kükenth.—Virginia (Elizabeth City Co., *G. G. Kennedy*, Apr. 8, 1887—G); North Carolina (Brunswick Co., *R. K. Godfrey* 49,005—Dk; NA); South Carolina (Horry Co., *L. Griscom* 16,435—G; US); Arkansas (Hot Springs Co., *D. Demaree* 16,697—NA).
- 164 *Carex normalis* Mack.—West Virginia (Webster Co., *H. A. Davis* 4372—NA).
- 92 [*Carex norvegica* of authors, not Willd.] = *C. mackenziei* Krecz., Fl. U.S.S.R. 3:183. 1935.
- 413a (*Carex norvegica* Willd. var. *inserrulata* (A. Kalela) Raymond, Nat. Canad. 77:60. 1950—Greenland; Northeastern North America.)
- 127 [*Carex nubicola* Mack.] = *C. haydeniana* Olney in *S. Wats. Bot. King's Exped.* 366. 1871.
- 344½ (*Carex obispoensis* Stacey, Leaflet West. Bot. 1:240. 1936—California.)
- 71½ (*Carex obovoidea* Cronquist, Madroño 7:78. 1943—Idaho.)
- 208 *Carex obtusata* Lil.—Utah (Daggett Co., *F. J. Hermann* 4788—H; Mo).
- 353 [*Carex oederi* of authors, not Retz.] = *C. serotina* Mérat, Fl. Paris, ed. 2, 2:54. 1821 (cf. Jour. Bot. 77:301. 1939)—Newfl., Magdalen Islands (cf. Mem. Jard. Bot. Montreal 20:10. 1951); and 353½. *C. demissa* Hornem. in Spreng. Syst. 3:822. 1826—Newfl., Que., N. S., Maine.
- 308 *Carex oligocarpa* Schkuhr—Georgia (Burke Co., *Pyron & McVaugh* 2502—H); Michigan (Berrien Co., *P. E. Hebert*, May 29, 1930—ND); Nebraska (Richardson Co., *H. C. Reynolds* 1690—NA).
- 35 *Carex onusta* Mack.—Oklahoma (Sequoyah Co., *R. Stratton* 3900—CU).
- 204 *Carex oreocharis* Holm—Arizona (Coconino Co., *J. J. Thornber* 2955—Ar).
- 328 *Carex oxylepis* Torr. & Hook.—Virginia (Chesterfield Co., *Fernald, Long & Smart* 5684—US).
- 328a *Carex oxylepis* var. *pubescens* J. K. Underw., Amer. Midl. Nat. 33:635. 1945—Tenn.
- 328a *Carex oxylepis* var. *pubescens* J. K. Underw.—Arkansas (Stone Co., *R. A. Reed* Gl-32—FS; H; NA).
- 169½ *Carex pachycarpa* Mack.—Nevada (Elko Co., *Mills & Beach* 1384—Cal; NA).
- 476 [*Carex paleacea* of authors, not Wahl.] = *C. paleacea* Wahl. var. *transatlantica* Fern., *Rhodora* 35:397. 1933—North America.
- 371 [*Carex pallescens* of authors, not L.] = *C. pallescens* L. var. *neogaea* Fern., *Rhodora* 44:306. 1942—North America.
- 412 *Carex parryana* Dewey—United States: North Dakota (Burke Co., *N. Hotchkiss* 6715—NA).
- 487 *Carex pauciflora* Lightf.—West Virginia (Grant Co., *H. A. Allard* 19,963—US; W Va.).

- 211 *Carex peckii* Howe—Wisconsin (Adams Co., *F. J. Hermann* 8735—Bl; G; H; NY; US; Ws); North Dakota (Ward Co., *N. Hotchkiss* 6601—NA); Saskatchewan (Saskatoon, *W. P. Fraser* 32—H).
- 243 *Carex pedunculata* Muhl.—Virginia (Montgomery Co., *F. J. Hermann* 10,661—Bl; G; H; NA; NY; US); Georgia (Dade Co., *F. J. Hermann* 10,188—G; Ga; NA; NY; US); Illinois (Jo Daviess Co., *F. J. Hermann* 8846—Ch; G; H; NY).
- 426½ *Carex pelocarpa* Hermann, *Rhodora* 39:492. 1937—Utah (Duchesne Co., *F. J. Hermann* 5094—G; H); Montana (Sweetgrass Co., *A. Cramer* 34—FS); Idaho (Custer Co., *Hitchcock & Muhllick* 10,941—CA).
- 223 *Carex pensylvanica* Lam.—Virginia (Madison Co., *F. R. Fosberg* 17,035—NA).
- 223a *Carex pensylvanica* f. *androgyna* Wheeler ex Hermann, *Amer. Midl. Nat.* 25:33. 1941—Michigan (Gratiot Co., *C. A. Davis*, June 29, 1883—H; Mh). [*Carex pensylvanica* var. *livoniensis* Farw., *Papers Mich. Acad. Sci.* 26, pt. 1:8. 1941. (Michigan)] = 220. *Carex communis* Bailey.
- 58½ *Carex percostata* Hermann, *Jour. Wash. Acad. Sci.* 40:282. 1950—Mexico (Chihuahua, *C. H. Muller* 3520—NA; Guerrero, *A. J. Sharp* 441,375—NA; Tn).
- 260 *Carex perstricta* Mack.—Tamaulipas, Mexico (*Stanford, Lauber & Taylor* 2057—US).
- 154 *Carex petasata* Dewey—Arizona (Coconino Co., *R. E. Collom* August. 30, 1944—US).
- 361a (*Carex petricosa* var. *edwardsii* Boivin, *Nat. Canad.* 75:207. 1948—Canada (Northwest Terr.).)
- 511 *Carex physocarpa* Presl—Utah (Duchesne Co., *F. J. Hermann* 5013—CA; G; H; Mo).
- 215 *Carex physorhyncha* Liebm.—Virginia (Dinwiddie Co., *Fernald & Long* 11,770—G).
- 247 *Carex picta* Steud.—Tennessee (Maury Co., *H. K. Svenson* 9051—Br).
- 45 [*Carex plana* Mack.] = *C. mühlenbergii* var. *enervis* Boott, *Ill. Carex* 124. 1862.
- 253 *Carex planostachys* Kunze—Nuevo Leon, Mexico (*Meyer & Rogers* 2524—NA); Tamaulipas, Mexico (*Stanford, Lauber & Taylor* 2206—US).
- 286 *Carex platyphylla* Carey—Kentucky (Wolfe Co., *McFarland & Lyle* 4250—Ky; NA); Michigan (St. Clair Co., *F. J. Hermann* 7372—H; NY).
- 404½ *Carex pluriflora* Hultén, *Fl. Alaska & Yukon* 2:367. 1942—Alaska.)
- 419 [*Carex podocarpa* Mack., not R. Br.] = in part *C. tolmiei* Boott (Wash., Ore., Ida., Mont., Wyo. and Utah) and in part 419½. *C. microchaeta* Holm (Yukon, Alaska and N. W. Terr.; cf. *A. E. Porsild*, *Bull. Nat. Mus. Canada* 121:117. 1951).
- 416a (*Carex podocarpa* f. *pallidior* Lepage, *Amer. Midl. Nat.* 46:756. 1951—Yukon.)
- 95 *Carex praeceptorum* Mack.—Nevada (Elko Co., *Mills & Beach* 1521—Cal; NA).
- 19 *Carex praegracilis* W. Boott—Michigan (Keweenaw Co., *Fernald & Pease* 3158—G); Texas (Jeff Davis Co., *B. H. Warnock* 137—US).
- 68 *Carex prairea* Dewey—Alberta (Ft. Saskatchewan, *G. H. Turner* 2603—NA).
- 151 *Carex praticola* Rydb.—Utah (Duchesne Co., *F. J. Hermann* 5096—CA).
- 140 *Carex preslii* Steud.—Nevada (Washoe Co., *W. A. Archer* 6721—NA).
- 496 *Carex pseudo-cyperus* L.—Indiana (Kosciusko Co., *C. C. Deam* 56,294—D); Saskatchewan (McKague, *A. J. Breitung* 19—NA).
- 294 *Carex purpurifera* Mack.—Kentucky (Estill Co., *Biltmore Herbarium* 220 b—H); Georgia ("Mountains," *A. W. Chapman* in 1886—Bl); Alabama (Marshall Co., *R. M. Harper* 3345—Bl; US).
- 8a (*Carex pyrenaica* var. *mondsii* L. Kelso, *Biol. Leaf.* 30:1. 1945—Colorado.)
- 303 1/3 *Carex quichensis* Hermann, *Jour. Wash. Acad. Sci.* 40:284. 1950—Guatemala (El Quiché, *A. J. Sharp* 45,144—NA; Tn).
- 4½ (*Carex rachillis* Maguire, *Brittonia* 5:199. 1944—Utah.)
- 479½ (*Carex ramenskii* Komarov, *Fedde Rep. Spec. Nov.* 13:164. 1914—Alaska.)
- 479½a (*Carex ramenskii* var. *caudata* Hultén, *Fl. Alaska & Yukon* 2:342. 1942—Alaska.)
- 404 *Carex rariflora* (Wahl.) J. E. Sm.—Ontario (James Bay, *R. H. Smith* 99—NA).

- 404a (*Carex rariflora* var. *androgyna* A. E. Porsild, *Sargentia* 4:20. 1943—Canada (Northwest Terr.).)
- 404b (*Carex rariflora* f. *erecta* Polunin, *Jour. Linn. Soc.* 52:372. 1943—American arctic.)
- 434 $\frac{1}{2}$ *Carex raymondii* Calder, *Rhodora* 54:246. 1952—Manitoba to Alberta and Alaska.
- 25 *Carex retroflexa* Muhl.—Georgia (Putnam Co., *Pyron & McVaugh* 2366—H); Kansas (Cherokee Co., A. S. Hitchcock, May 1896—Kn).
- 523 *Carex retrorsa* Schwein.—Indiana (Lake Co., W. S. Moffatt, July 2, 1893—D); Utah (Weber Co., A. O. Garrett 6915—H).
- 264a *Carex richardsonii* f. *exserta* Fern., *Rhodora* 44:290. 1942—Illinois.
- 180 [*Carex richii* (Fern.) Mack.] = *C. straminea* Willd. in Schuhr, *Riedgr.* 49:1801. (cf. *Rhodora* 40:329. 1938)—The statement in *Castanea* 16:34 (1951) that *C. straminea* "is very doubtfully distinct from *C. alata* from which it differs in only minor details" is quite misleading. Both of the species are so well marked (belonging, indeed, to different subsections of the genus) that to anyone having more than a most superficial acquaintance with sedges there is no possibility of confusing the two.
- 438a (*Carex rigida* var. *subconcoloroides* (L. Kelso) L. Kelso, *Biol. Leaflet* 51:2. 1950—Colorado.)
- 330 $\frac{1}{2}$ *Carex roanensis* Hermann, *Castanea* 12:4. 1948—Tennessee (Carter Co., D. M. Brown 255—Dk; NA).
- 28 *Carex rosea* Schuhr—Kansas (Wyandotte Co., K. K. Mackenzie, May 1897—Kn).
- 229 *Carex rossii* Boott—Arizona (Coconino Co., *Eastwood & Howell* 888—CA); Nevada (Elko Co., S. Watson 1260—US); Alberta (Jasper Nat'l. Park, W. P. Fraser 8—NA).
- 520 *Carex rostrata* Stokes—Maryland (Prince Georges Co., L. F. Ward—US).
- 520a (*Carex rostrata* var. *anticostensis* (Fern.) Fern., *Rhodora* 48:146. 1946—Quebec.)
- 235 *Carex rugosperma* Mack.—Virginia (Fauquier Co., H. A. Allard 1175—NA); Kentucky (Wolfe Co., *McFarland & Lyle* 4234—Ky; NA); Indiana (Lake Co., L. M. Umbach, May 28, 1898—D).
- 20a *Carex sartwellii* var. *stenorrhyncha* Hermann, *Rhodora* 40:78. 1938—Indiana Lake Co., C. C. Deam 53,920—D).
- 512a (*Carex saxatilis* var. *laxa* Ohwi, *Jour. Jap. Bot.* 11:408. 1935; Raymond, *Bull. Soc. Bot. France* 99:197. 1952—Quebec.)
- 476a (*X Carex saxeni* Raymond, *Canad. Jour. Research* 28, sec. C:421. 1950—*C. paleacea* x *recta*.)
- 397 *Carex scabrata* Schwein.—Indiana (St. Joseph Co., P. E. Hebert 1467—ND).
- 358a (*X Carex senayi* Raymond, *Bull. Soc. Bot. France* 99:194. 1952—*C. flava* x *lepidocarpa* var. *nelmesiana*: *X C. pieperiana* Raymond, not P. Junge.)
- 102 *Carex seorsa* Howe—Michigan (Berrien Co., P. E. Hebert, May 30, 1930—ND).
- 22 [*Carex siccata* Dewey] = *C. foenea* Willd., *Enum. pl.* 957. 1809. (cf. *Rhodora* 40:325. 1938).
- 17 *Carex simulata* Mack.—Nevada (Elko Co., P. Train 959—CA; H; NA).
- 365 $\frac{1}{2}$ (*Carex sonomensis* Stacey, *Leaflet West. Bot.* 2:63. 1937—California.)
- 124 $\frac{1}{2}$ (*Carex soperi* Raup, *Sargentia* 6:129. 1947—Canada (Mackenzie Distr.).)
- 53 *Carex sparganioides* Muhl.—North Carolina (Jackson Co., R. K. Godfrey 51,259—Dk; NA); Nebraska (Richardson Co., H. C. Reynolds 1478—NA).
- 433 $\frac{1}{3}$ *Carex specuicola* J. T. Howell, *Leaflet West. Bot.* 5:148. 1949—Arizona (Coconino Co., J. T. Howell 24,609—CA; H).
- 350 *Carex sprenghelii* Dewey—British Columbia (Prince George, J. W. Eastham 11,631—NA).
- 263 $\frac{1}{2}$ (*Carex standleyana* Steyermark, *Ceiba* 3:23. 1952—Guatemala & Honduras.)
- 262 *Carex stellata* Mack.—United States: Texas (Brewster Co., B. H. Warnock 20,090—NA); Coahuila, Mexico (C. H. Muller 3305—NA).
- 130 $\frac{1}{2}$ *Carex stenoptila* Hermann, *Leaflet West. Bot.* 4:194. 1945—Colorado (Montrose Co., D. Castello 4501—NA).
- 110a (*Carex sterilis* var. *rousseauiana* Raymond, *Nat. Canad.* 77:62. 1950—Quebec.)

- 324¹/₄ (*Carex steyermarkii* Standl., Field Mus. Pub. Bot. 23:196. 1947—Guatemala.)
 76 *Carex stipata* var. *maxima* Chapm.—District of Columbia (T. H. Kearney, May 22, 1897—US); Indiana (Porter Co., L. M. Umbach, June 16, 1900—D).
- 180 *Carex straminea* Willd. (*C. richii* (Fern.) Mack.)—Michigan (Kalamazoo Co., F. J. Hermann 9004—G; Mh; NY); Illinois (Menard Co., E. Hall in 1861—US).
- 184 [*Carex straminea* of authors, not Willd.] = *C. albolutescens* Schwein., Ann. Lyc. N. Y. 1:66. 1824 (cf. *Rhodora* 40:329. 1938).
- 170 *Carex straminiformis* Bailey—Utah (Utah Co., E. Castle 72C—NA).
- 297 *Carex striatula* Michx.—West Virginia (Wayne Co., L. Plymale 381—NA).
- 465 *Carex stricta* var. *strictior* (Dewey) Carey—Missouri (Reynolds Co., J. A. Steyermark 71,303—Ch; NA).
- 178 *Carex suberecta* Olney—Missouri (Shannon Co., J. A. Steyermark 5479—NA).
- 139 *Carex subfusca* W. Boott—Canada: British Columbia (Vancouver, J. W. Eastham 9525—NA).
- 505 X *Carex subimpressa* Clokey—Michigan (Montcalm Co., C. A. Davis, June 10, 1897—H; Mh); Missouri (Lewis Co., J. A. Steyermark 26,489—Mo).
- 8¹/₂ *Carex subnigricans* Stacey, Leaf. West. Bot. 2:167. 1939—California, Nevada & Idaho.
- 479 *Carex subspathacea* Wormsk.—Ontario (James Bay, R. H. Smith 157—H; NA).
- 458 *Carex substricta* (Küenth.) Mack.—Missouri (Carter Co., J. A. Steyermark 11,735—Mo); Colorado (Clear Creek Co., U. T. Waterfall 3401—US); Oregon (Grant Co., R. M. Porter 1022—FS; NA).
- 292 *Carex styloflexa* Buckl.—Indiana (Decatur Co., C. C. Deam 8149—D).
- 138 *Carex teneraeformis* Mack.—Nevada (Washoe Co., W. A. Archer 5608—CA; H; NA).
- 256¹/₂ (*Carex terrae*—novae Fern., *Rhodora* 44:290. 1942—Newfoundland.)
- 275 *Carex tetanica* Schkuhr—Nebraska (Thomas Co., P. A. Rydberg, June 23, 1893 Nb).
- 26 *Carex texensis* (Torr.) Bailey—Indiana (Posey Co., F. J. Hermann 6126—H); Oklahoma (Cherokee Co., R. Bebb 5280—NA); California (Los Angeles Co., F. L. Stamey, May, 1951—NA).
- 419 *Carex tolmiei* Boott, in Hook. Fl. Bor. Amer. 2:224. 1839. (*C. podocarpa* Mack. in part, not R. Br.)—Utah (Duchesne Co., F. J. Hermann 4988—CA; H).
- 236 *Carex tonsa* (Fern.) Bickn.—Virginia (Southampton Co., Fernald & Long 6951—G); South Carolina (Burnt (?) Bay, J. B. Norton C25—Bl); Iowa (Allamakee Co., W. L. Tolstead, Sept. 13, 1937—IS).
- 472 *Carex torta* Boott—Kentucky (Powell Co., M. E. Wharton 1611—NA); Georgia (Screven Co., D. E. Eyles 6908—NA).
- 186 *Carex tribuloides* Wahl.—Kansas (Wyandotte Co., K. K. Mackenzie, June 7, 1896—Kn); British Columbia (Creston, J. W. Eastham, July 14, 1941—NA).
- 504 *Carex trichocarpa* Muhl.—Maryland (Howard Co., J. B. S. Norton 1770—Md).
- 218 *Carex turbinata* Liebm.—Puebla, Mexico (A. J. Sharp 44,431—NA).
- 509 *Carex typhina* Michx.—Michigan (Ingham Co., L. H. Bailey, July 1, 1886—MS).
- 76 [*Carex uberior* (C. Mohr) Mack.] = *C. stipata* var. *maxima* Chapm., in Boott, Ill. *Carex* 122. 1862.
- 483 *Carex ultra* Bailey—Mexico: Nuevo Leon (A. J. Sharp 45,728—NA).
- 234 *Carex umbellata* Schkuhr—Virginia (Sussex Co., Fernald & Long 6952—G).
- 429¹/₂ (*Carex uncomphagre* L. Kelso, Biol. Leaf. 38:1. 1947—Colorado.)
- 413 [*Carex vahlII* Schkuhr] = in part *C. norvegica* Retz. (Arctic alpine; Greenland to Labrador and n. Hudson Bay) and in part 413¹/₂. *C. media* R. Br. (Woodland: s.e. Canada to Colorado, Washington & Alaska). (cf. *Rhodora* 44:303. 1942).
- 31 *Carex vallicola* Dewey—Utah (Daggett Co., F. J. Hermann 4860—H); California (Mono Co., R. F. Hoover 5562—NA); Mexico (State of Mexico, A. J. Sharp 44,109—NA).
- 11a (*Carex vernacula* var. *hobsonii* Maguire, Brittonia 5:199. 1944—Utah.)

- 402 *Carex verrucosa* Muhl.—North Carolina (Brunswick Co., R. K. Godfrey 49, 189—NA).
 515 *Carex vesicaria* L.—Arizona (Coconino Co., J. F. Arnold 31—Ar).
 515a (*Carex vesicaria* f. *fluitans* Raymond, Nat. Canad. 77:65. 1950—Quebec.)
 48 *Carex vires* Lam.—Massachusetts (Essex Co., J. W. Congdon, June 28, 1878—US).
 374 *Carex virescens* Muhl.—Michigan (Berrien Co., G. L. Ames, June 14, 1869—Mh).
 354a (*Carex viridula* f. *clandestina* Raymond, Nat. Canad. 77:63. 1950—Quebec.)
 354b *Carex viridula* f. *intermedia* (Dudley) Hermann, in Deam Fl. Ind. 256. 1940.
 354c (*Carex viridula* f. *rousseauiana* (Victorin) Raymond, Nat. Canad. 77:63. 1950—Quebec.)
 64 *Carex vulpinoidea* Michx.—Alberta (Pigeon Lake, G. H. Turner 7691—NA).
 64a *Carex vulpinoidea* var. *pynoccephala* Hermann, Rhodora 38:363. 1936—Michigan (Emmet Co., F. J. Hermann 6408—G; H); Indiana (Steuben Co., C. C. Deam, June 17, 1903—D); Minnesota (Hubbard Co., J. B. Moyle 820—Mh).

199a *Carex willdenowii* var. *megarrhyncha*, var. nov.

A varietate typica recedit perigyniis 8-9 mm. longis in rostrum 5 mm. longum attenuatis, achaeniis 3 mm. longis, 2 mm. latis, pedunculis 0.2-4.5 mm. diam. foliorum apicibus plerumque acutis. A rather striking extreme of *Carex willdenowii* in its long perigynia (8-9 mm. rather than 5 mm.) with body (3 mm. long) gradually tapering into the very long (5 mm.) broad-based beak, in its large achenes (3 x 2 mm. rather than 2.25 x 1.3 mm.), its capillary peduncles (0.2-0.45 rather than 0.5-1.1 mm. wide), its generally acute-tipped leaves (in typical *C. willdenowii* attenuate to a prolonged slender tip) and its variable staminate spike and scales. Dr. Stanley J. Smith independently noted the plant in the field, and informs me that he had observed it in Georgia from the lower Chattahoochee drainage, an area which, in fact, includes all of the five Georgia stations cited below. The distinctions from typical *C. willdenowii* were so marked in all of the Georgia collections, the Louisiana specimen and one from Alabama that it appeared to be specifically distinct until the discovery of three of Dr. Roland Harper's collections and one of Dr. H. K. Svenson's from northern Alabama which were completely transitional (*Harper* 3512, Hale Co.; *Harper* 3935, Walker Co.; *Harper* 3657, Blount Co.; Svenson 10,196, Jackson Co.).

Georgia: JASPER Co.—open woods along small stream, 3½ mi. east of Ocmulgee, S. J. Smith & W. H. Duncan 4872, Apr. 6, 1949 (Type—NA); HOUSTON Co.—damp shady woods, ca. 2 mi. south of Elko, R. M. Harper 2131, April 16, 1904 (US); STEWART Co.—rich woods, ca. 2 mi. northwest of Lumpkin, R. M. Harper 2226, May 25, 1904 (US); DECATUR Co.—moist rich woods, 1 mi. north of River Junction (Fla.), J. H. Pyron & R. McVaugh 2231, March 21, 1938 (NA), and dry, wooded slope, bluff along Flint River 1 mi. north of Chattahoochee (Fla.), R. F. Thorne, W. C. Muenscher & S. J. Smith 3108, Apr. 14, 1947 (US). Alabama: TUSCALOOSA Co.—sandstone ledges in ravine tributary to Hurricane Creek, ca. 1 mi. south of Peterson, R. M. Harper 3364, May 9, 1935 (US). Louisiana: IBERIA PARISH—moist low woods, Avery Island, D. S. & H. B. Correll 9557, July 11-15, 1938 (NA).

- 277 *Carex woodii* Dewey—Indiana (St. Joseph Co., C. C. Deam 54,861—D); Illinois (Jo Daviess Co., F. J. Hermann 8840—Ch; G; H; NY; US); Nebraska (Kearney Co., H. Hapemann—Nb).
 42 *Carex xalapensis* Kunth—Puebla, Mexico (A. J. Sharp 44,434—NA).

GEOGRAPHIC LIST

United States

- | | | | |
|------|--|------|--|
| 288a | (<i>C. abscondita</i> var. <i>rostellata</i> Fern.) | 213a | <i>C. arctitecta</i> var. <i>subtilirostris</i> Hermann |
| 288b | (<i>X C. abscondiformis</i> Fern.) | 78½ | (<i>C. bayardi</i> Fern.) |
| 117a | (<i>C. angustior</i> var. <i>gracilenta</i> Clausen & Wahl) | 444a | (<i>C. campylocarpa</i> subsp. <i>affinis</i> Maguire & Holmgren) |
| 475a | (<i>C. aquatilis</i> var. <i>plumbeophila</i> L. Kelso) | 432a | (<i>C. chalciolepis</i> var. <i>larimerana</i> L. Kelso) |
| 3½ | <i>C. arctogena</i> H. Smith | | |

- 73 *C. chihuahuensis* Mack.
 155 $\frac{1}{2}$ (*C. constanceana* Stacey)
 312 $\frac{1}{2}$ (*C. corrugata* Fern.)
 475a (*C. crinita* var. *brevicrinis* Fern.)
 240 $\frac{1}{2}$ *C. curtorum* Stacey
 131 $\frac{1}{2}$ (*C. danaensis* Stacey)
 399a *X C. deamii* Hermann
 340a (*C. debilis* var. *intercursa* Fern.)
 289a (*C. digitalis* var. *asymetrica* Fern.)
 289b (*C. digitalis* var. *macropoda* Fern.)
 105a *C. interior* var. *charlestonensis* Clokey
 105b *C. interior* f. *keweenawensis* (Hermann) Fern.
 529b (*C. intumescens* var. *fernaldii* f. *ventricosa* Fern.)
 385 *C. lasiocarpa* var. *americana* Fern.
 296a *C. laxiflora* var. *serrulata* Hermann
 262 $\frac{1}{2}$ *C. muriculata* Hermann
 413a (*C. norvegica* var. *inserrulata* (Kalela) Raymond)
 344 $\frac{1}{2}$ (*C. obispoensis* Stacey)
 71 $\frac{1}{2}$ (*C. obovoidea* Cronquist)
 328a *C. oxylepis* var. *pubescens* J. K. Underw.
 476 *C. paleacea* var. *transatlantica* Fern.
 371 *C. pallescens* var. *neogaea* Fern.
 412 *C. parryana* Dewey
 426 $\frac{1}{2}$ *C. pelocarpa* Hermann
 223a *C. pensylvanica* f. *androgyna* Wheeler
- 8a (*C. pyrenaica* var. *mondsii* L. Kelso)
 4 $\frac{1}{2}$ (*C. rachillis* Maguire)
 264a *C. richardsonii* f. *exserta* Fern.
 438a (*C. rigida* var. *subconcoloroides* L. Kelso)
 351 $\frac{1}{2}$ *C. distans* L.
 228 $\frac{1}{2}$ (*C. diversistylis* W. A. Roach)
 19 $\frac{1}{2}$ *C. divisa* Huds.
 149 $\frac{1}{2}$ (*C. eastwoodiana* Stacey)
 423 1/3 (*C. elbertiana* L. Kelso)
 2 $\frac{1}{2}$ (*C. elynaeformis* Porsild)
 222 $\frac{1}{2}$ (*C. exlebeniana* L. Kelso)
 424 $\frac{1}{2}$ (*C. estesiana* L. Kelso)
 271 $\frac{1}{2}$ *C. garberi* Fern.
 271 $\frac{1}{2}$ a *C. garberi* var. *bifaria* Fern.
 427 $\frac{1}{2}$ (*C. hagiana* L. Kelso)
 469 $\frac{1}{2}$ (*C. interimus* Maguire)
 330 $\frac{1}{2}$ *C. roanensis* Hermann
 20a *C. sartwellii* var. *stenorrhyncha* Hermann
 365 $\frac{1}{2}$ (*C. sonomensis* Stacey)
 433 1/3 *C. specuicola* J. T. Howell
 262 *C. stellata* Mack.
 130 $\frac{1}{2}$ *C. stenoptila* Hermann
 8 $\frac{1}{2}$ *C. subnigricans* Stacey
 429 $\frac{1}{2}$ (*C. uncompaghre* L. Kelso)
 11a (*C. vernacula* var. *hobsonii* Maguire)
 64a *C. vulpinoidea* var. *pynoccephala* Hermann
 199a *C. willdenowii* var. *megarrhyncha* Hermann

ALABAMA

- 288a (*C. abscondita* var. *rostellata* Fern.)
 285 *C. careyana* Torr.
 80 *C. conjuncta* Boott
 312 $\frac{1}{2}$ (*C. corrugata* Fern.)
 299 *C. crebriflora* Wieg.
- 259 *C. eburnea* Boott
 401 *C. jootii* Bailey
 294 *C. purpurifera* Mack.
 199a *C. willdenowii* var. *megarrhyncha* Hermann

ARIZONA

- 457 *C. aquatilis* Wahl.
 195 *C. athrostachya* Olney
 272 *C. aurea* Nutt.
 167 *C. brevior* (Dewey) Mack.
 73 *C. chihuahuensis* Mack.
 240 $\frac{1}{2}$ *C. curtorum* Stacey
 205 *C. filifolia* Nutt.
 271 *C. hassei* Bailey
 127 *C. haydeniana* Olney
- 449 *C. kelloggii* W. Boott
 276 *C. meadii* Dewey
 125 *C. microptera* Mack.
 204 *C. oreocharis* Holm
 154 *C. petasata* Dewey
 229 *C. rossii* Boott
 433 1/3 *C. specuicola* J. T. Howell
 515 *C. vesicaria* L.

ARKANSAS

- 62 *C. annectens* Bickn.
 201 *C. backii* Boott
 259 *C. eburnea* Boott
 464 *C. emoryi* Dewey
 189 *C. muskingumensis* Dewey
- 217 *C. nigromarginata* var. *floridana* (Schwein.) Kükenth.
 328a *C. oxylepis* var. *pubescens* J. K. Underw.

CALIFORNIA

| | | | |
|-------|---------------------------------|------|-----------------------------------|
| 131/2 | (<i>C. danaensis</i> Stacey) | 81/2 | <i>C. subnigricans</i> Stacey |
| 205 | <i>C. filifolia</i> Nutt. | 26 | <i>C. texensis</i> (Torr.) Bailey |
| 344/2 | (<i>C. obispoensis</i> Stacey) | 31 | <i>C. vallicola</i> Dewey |
| 365/2 | (<i>C. sonomensis</i> Stacey) | | |

COLORADO

| | | | |
|---------|---|--------|--|
| 457a | (<i>C. aquatilis</i> var. <i>plumbeophila</i> L. Kelso) | 271 | <i>C. hassei</i> Bailey |
| | | 70 | <i>C. jonesii</i> Bailey |
| 432a | (<i>C. chalciolepis</i> var. <i>larimerana</i> L. Kelso) | 166 | <i>C. molesta</i> Mack. |
| | | 71 | <i>C. neurophora</i> Mack. |
| 413 1/3 | (<i>C. elbertiana</i> L. Kelso) | 8a | (<i>C. pyrenaica</i> var. <i>mondsii</i> L. Kelso) |
| 21/2 | (<i>C. elynaeformis</i> Porsild) | | |
| 222/2 | (<i>C. erlebeniana</i> L. Kelso) | 438a | (<i>C. rigida</i> var. <i>subcoloroides</i> L. Kelso) |
| 424/2 | (<i>C. estesiana</i> L. Kelso) | | |
| 49 | <i>C. grvida</i> Bailey | 1301/2 | <i>C. stenoptila</i> Hermann |
| 50 | <i>C. grvida</i> var. <i>lunelliana</i> (Mack.) Hermann | 458 | <i>C. substricta</i> (Kükenth.) Mack. |
| | | 4291/2 | (<i>C. uncomphagre</i> L. Kelso) |
| 4271/2 | (<i>C. hagiana</i> L. Kelso) | | |

CONNECTICUT

| | | | |
|-----|---------------------------|--|--|
| 521 | <i>C. bullata</i> Schkuhr | | |
|-----|---------------------------|--|--|

DISTRICT OF COLUMBIA

| | | | |
|-----|---|----|---|
| 117 | [<i>C. angustior</i> Mack.]-Delete report. | 76 | <i>C. stipata</i> var. <i>maxima</i> Chapm. |
|-----|---|----|---|

FLORIDA

| | | | |
|------|---|--|--|
| 289a | (<i>C. digitalis</i> var. <i>asymetrica</i> Fern.) | | |
|------|---|--|--|

GEORGIA

| | | | |
|-----|------------------------------------|------|---|
| 342 | <i>C. allegheniensis</i> Mack. | 308 | <i>C. oligocarpa</i> Schkuhr |
| 213 | <i>C. atritecta</i> Mack. | 243 | <i>C. pedunculata</i> Muhl. |
| 283 | <i>C. austrocarolina</i> Bailey | 294 | <i>C. purpurifera</i> Mack. |
| 93 | <i>C. brunescens</i> (Pers.) Poir. | 25 | <i>C. retroflexa</i> Muhl. |
| 299 | <i>C. crebriflora</i> Wieg. | 472 | <i>C. torta</i> Boott |
| 214 | <i>C. emmonsii</i> Dewey | 199a | <i>C. willdenowii</i> var. <i>megarhyncha</i> Hermann |
| 377 | <i>C. hirsutella</i> Mack. | | |

IDAHO

| | | | |
|-------|----------------------------------|--------|-------------------------------|
| 228 | <i>C. brevipes</i> W. Boott | 4261/2 | <i>C. pelocarpa</i> Hermann |
| 711/2 | (<i>C. obovoidea</i> Cronquist) | 81/2 | <i>C. subnigricans</i> Stacey |

ILLINOIS

| | | | |
|-----|--|------|--|
| 181 | <i>C. cumulata</i> Mack. | 264a | <i>C. richardsonii</i> f. <i>exserta</i> Fern. |
| 291 | <i>C. laxiculmis</i> var. <i>copulata</i> (Bailey) Fern. | 180 | <i>C. straminea</i> Wild. |
| | | 277 | <i>C. woodii</i> Dewey |
| 243 | <i>C. pedunculata</i> Muhl. | | |

INDIANA

| | | | |
|--------|---|------|--|
| 498 | <i>C. acutiformis</i> Ehrh. | 496 | <i>C. pseudo-cyperus</i> L. |
| 213a | <i>C. atritecta</i> var. <i>subtilirostris</i> Hermann | 523 | <i>C. retrorsa</i> Schwein. |
| | | 235 | <i>C. rugosperma</i> Mack. |
| 272 | <i>C. aurea</i> Nutt. | 20a | <i>C. sartwellii</i> var. <i>stenorrhyncha</i> Hermann |
| 181 | <i>C. cumulata</i> Mack. | | |
| 399a | <i>X C. deamii</i> Hermann | 397 | <i>C. scabrata</i> Schwein. |
| 289b | (<i>C. digitalis</i> var. <i>macropoda</i> Fern.) | 76 | <i>C. stipata</i> var. <i>maxima</i> Chapm. |
| | | 292 | <i>C. styloflexa</i> Buckl. |
| 2711/2 | <i>C. garberi</i> Fern. | 26 | <i>C. texensis</i> (Torr.) Bailey |
| 50 | <i>C. grvida</i> var. <i>lunelliana</i> (Mack.) Hermann | 354b | <i>C. viridula</i> f. <i>intermedia</i> (Dudley) Hermann |
| 222 | <i>C. heliophila</i> Mack. | 64a | <i>C. vulpinoidea</i> var. <i>pynccephala</i> Hermann |
| 106 | <i>C. howei</i> Mack. | | |
| 296a | <i>C. laxiflora</i> var. <i>serrulata</i> Hermann | 277 | <i>C. woodii</i> Dewey |
| 37 | <i>C. mesochorea</i> Mack. | | |

IOWA

| | | | |
|-----|--------------------------------|--|--|
| 236 | <i>C. tonsa</i> (Fern.) Bickn. | | |
|-----|--------------------------------|--|--|

KANSAS

- | | | | |
|-----|------------------------------------|-----|-----------------------------|
| 377 | <i>C. hirsutella</i> Mack. | 28 | <i>C. rosea</i> Schkuhr |
| 125 | <i>C. microdonta</i> Torr. & Hook. | 186 | <i>C. tribuloides</i> Wahl. |
| 25 | <i>C. retroflexa</i> Muhl. | | |

KENTUCKY

- | | | | |
|------|--|------|---|
| 331 | <i>C. aestivalis</i> M. A. Curtis | 302 | <i>C. gracilescens</i> Steud. |
| 184 | <i>C. albolutescens</i> Schwein. | 49 | <i>C. gravida</i> Bailey |
| 342 | <i>C. allegheniensis</i> Mack. | 529 | <i>C. intumescens</i> Rudge |
| 62 | <i>C. annectens</i> Bickn. | 296a | <i>C. laxiflora</i> var. <i>serrulata</i> Hermann |
| 527 | <i>C. baileyi</i> Britt. | 298 | <i>C. leptonervia</i> Fern. |
| 167 | <i>C. brevior</i> (Dewey) Mack. | 286 | <i>C. platyphylla</i> Carey |
| 285 | <i>C. careyana</i> Torr. | 294 | <i>C. purpurifera</i> Mack. |
| 378 | <i>C. caroliniana</i> Schwein. | 235 | <i>C. rugosperma</i> Mack. |
| 475a | (<i>C. crinita</i> var. <i>brevicrinis</i> Fern.) | 472 | <i>C. torta</i> Boott |
| 214 | <i>C. emmonsii</i> Dewey | | |

LOUISIANA

- | | | | |
|------|--|------|--|
| 289b | (<i>C. digitalis</i> var. <i>macropoda</i> Fern.) | 199a | <i>C. willdenowii</i> var. <i>megarrhyncha</i> Hermann |
|------|--|------|--|

MAINE

- | | |
|------|---|
| 271½ | <i>C. garberi</i> var. <i>bifaria</i> Farn. |
|------|---|

MARYLAND

- | | | | |
|------|--|-----|-------------------------------|
| 21 | <i>C. arenaria</i> L. | 352 | <i>C. extensa</i> Gooden. |
| 289b | (<i>C. digitalis</i> var. <i>macropoda</i> Fern.) | 533 | <i>C. gigantea</i> Rudge |
| | | 500 | <i>C. hyalinolepis</i> Steud. |
| 351½ | <i>C. distans</i> L. | 520 | <i>C. rostrata</i> Stokes |
| 19½ | <i>C. divisa</i> Huds. | 504 | <i>C. trichocarpa</i> Muhl. |

MASSACHUSETTS

- | | |
|----|-----------------------|
| 48 | <i>C. virens</i> Lam. |
|----|-----------------------|

MICHIGAN

- | | | | |
|------|--|------|---|
| 52 | <i>C. aggregata</i> Mack. | 34 | <i>C. leavenworthii</i> Dewey |
| 184 | <i>C. albolutescens</i> Schwein. | 182 | <i>C. longii</i> Mack. |
| 62 | <i>C. annectens</i> Bickn. | 308 | <i>C. oligocarpa</i> Schkuhr |
| 457 | <i>C. aquatilis</i> Wahl. | 223a | <i>C. pensylvanica</i> f. <i>androgyna</i> Wheeler |
| 502 | <i>C. atherodes</i> Spreng. | | |
| 174 | <i>C. bicknellii</i> Britt. | 286 | <i>C. platyphylla</i> Carey |
| 119 | <i>C. cephalantha</i> (Bailey) Bickn. | 19 | <i>C. praegracilis</i> W. Boott |
| 329 | <i>C. davisii</i> Schwein. & Torr. | 102 | <i>C. seorsa</i> Howe |
| 165 | <i>C. festucea</i> Schkuhr | 180 | <i>C. straminea</i> Willd. |
| 507 | <i>C. frankii</i> Kunth | 505 | X. <i>C. subimpressa</i> Clokey |
| 271½ | <i>C. garberi</i> Fern. | 509 | <i>C. typhina</i> Michx. |
| 463 | <i>C. haydenii</i> Dewey | 374 | <i>C. virescens</i> Muhl. |
| 386 | <i>C. hirta</i> L. | 64a | <i>C. vulpinoidea</i> var. <i>pyncnocephala</i> Hermann |
| 105b | <i>C. interior</i> f. <i>keweenawensis</i> (Hermann) Fern. | | |

MINNESOTA

- | | | | |
|-----|-------------------------------|-----|---|
| 310 | <i>C. katahdinensis</i> Fern. | 64a | <i>C. vulpinoidea</i> var. <i>pyncnocephala</i> Hermann |
|-----|-------------------------------|-----|---|

MISSOURI

- | | | | |
|------|--|-----|--|
| 185 | <i>C. alata</i> T. & G. | 465 | <i>C. strica</i> var. <i>strictior</i> (Dewey) Carey |
| 220 | <i>C. communis</i> Bailey | | |
| 245 | <i>C. conoidea</i> Schkuhr | 178 | <i>C. suberecta</i> Olney |
| 475a | (<i>C. crinita</i> var. <i>brevicrinis</i> Fern.) | 505 | X <i>C. subimpressa</i> Clokey |
| 307 | <i>C. microdonta</i> Torr. & Hook. | 458 | <i>C. substricta</i> (Kükenth.) Mack. |

MONTANA

| | | | |
|------|----------------------------------|------|---|
| 366 | <i>C. ablata</i> Bailey | 427 | <i>C. epipilosa</i> Mack. |
| 441 | <i>C. chimphila</i> Holm | 271½ | <i>C. garberi</i> var. <i>bifaria</i> Fern. |
| 149½ | (<i>C. eastwoodiana</i> Stacey) | 136 | <i>C. illota</i> Bailey |
| 126 | <i>C. ebenea</i> Rydb. | 426½ | <i>C. pelocarpa</i> Hermann |

NEBRASKA

| | | | |
|-----|---|-----|-------------------------------|
| 213 | <i>C. artitecta</i> Mack. | 309 | <i>C. hitchcockiana</i> Dewey |
| 33 | <i>C. cephalophora</i> Muhl. | 200 | <i>C. jamesii</i> Schwein. |
| 80 | <i>C. conjuncta</i> Boott | 499 | <i>C. lacustris</i> Willd. |
| 329 | <i>C. davisii</i> Schwein. & Torr. | 34 | <i>C. leavenworthii</i> Dewey |
| 165 | <i>C. festucacea</i> Schkuhr | 308 | <i>C. oligocarpa</i> Schkuhr |
| 507 | <i>C. frankii</i> Kunth | 53 | <i>C. sparganioides</i> Muhl. |
| 50 | <i>C. gravida</i> var. <i>lunelliana</i> (Mack.) Hermann | 275 | <i>C. tetanica</i> Schkuhr |
| | | 277 | <i>C. woodii</i> Dewey |

NEVADA

| | | | |
|------|--|------|-------------------------------|
| 3½ | <i>C. arctogena</i> H. Smith | 407 | <i>C. limosa</i> L. |
| 502 | <i>C. atherodes</i> Spreng. | 257 | <i>C. multicaulis</i> Bailey |
| 228 | <i>C. brevipes</i> W. Boott | 71 | <i>C. neurophora</i> Mack. |
| 206 | <i>C. elynoides</i> Holm | 169½ | <i>C. pachycarpa</i> Mack. |
| 271½ | <i>C. garberi</i> Fern. | 95 | <i>C. praeceptorum</i> Mack. |
| 2 | <i>C. hepburnii</i> Boott | 140 | <i>C. preslii</i> Steud. |
| 105a | <i>C. interior</i> subsp. <i>charlestonensis</i> Clokey | 229 | <i>C. rossii</i> Boott |
| | | 17 | <i>C. simulata</i> Mack. |
| 449 | <i>C. kelloggii</i> W. Boott | 8½ | <i>C. subnigricans</i> Stacey |
| 150 | <i>C. leporinella</i> Mack. | 138 | <i>C. teneraeformis</i> Mack. |

NEW HAMPSHIRE

| | |
|----|------------------------------|
| 3½ | <i>C. arctogena</i> H. Smith |
|----|------------------------------|

NEW JERSEY

| | |
|----|-------------------------|
| 81 | <i>C. kobomugi</i> Ohwi |
|----|-------------------------|

NEW YORK

| | |
|------|-------------------------|
| 271½ | <i>C. garberi</i> Fern. |
|------|-------------------------|

NORTH CAROLINA

| | | | |
|------|--|------|--|
| 21 | <i>C. arenaria</i> L. | 529b | (<i>C. intumescens</i> var. <i>fernaldii</i> f. <i>ventricosa</i> Fern.) |
| 194 | <i>C. argyrantha</i> Tuckerm. | | |
| 213 | <i>C. artitecta</i> Mack. | 401 | <i>C. jorii</i> Bailey |
| 282 | <i>C. chapmanii</i> Steud. | 491 | <i>C. lonchocarpa</i> Willd. |
| 475a | (<i>C. crinita</i> var. <i>brevicrinis</i> Fern.) | 217 | <i>C. nigromarginata</i> var. <i>floridana</i> (Schwein.) Kükenth. |
| 340a | (<i>C. debilis</i> var. <i>intercursa</i> Fern.) | | <i>C. sparganioides</i> Muhl. |
| 19½ | <i>C. divisa</i> Huds. | 53 | <i>C. verrucosa</i> Muhl. |
| 100 | <i>C. exilis</i> Dewey | 402 | |
| 106 | <i>C. howei</i> Mack. | | |

NORTH DAKOTA

| | | | |
|------|-------------------------|-----|--------------------------|
| 259 | <i>C. eburnea</i> Boott | 412 | <i>C. parryana</i> Dewey |
| 271½ | <i>C. garberi</i> Fern. | 211 | <i>C. peckii</i> Howe |

OKLAHOMA

| | | | |
|----|------------------------|----|-----------------------------------|
| 35 | <i>C. onusta</i> Mack. | 26 | <i>C. texensis</i> (Torr.) Bailey |
|----|------------------------|----|-----------------------------------|

OREGON

| | | | |
|------|--|-----|--|
| 228½ | (<i>C. diversistylis</i> W. A. Roach) | 385 | <i>C. lasiocarpa</i> var. <i>americana</i> Fern. |
| 149½ | (<i>C. eastwoodiana</i> Stacey) | 458 | <i>C. substricta</i> (Kükenth.) Mack. |

PENNSYLVANIA

| | | | |
|------|--|------|---|
| 117a | (<i>C. angustior</i> var. <i>gracilentia</i> Clausen & Wahl) | 258 | <i>C. geyeri</i> Boott |
| | | 296a | <i>C. laxiflora</i> var. <i>serrulata</i> Hermann |
| 271½ | <i>C. garberi</i> Fern. | 166 | <i>C. molesta</i> Mack. |

SOUTH CAROLINA

- | | | | |
|-----|---------------------------------|-----|--------------------------------------|
| 278 | <i>C. biltmoreana</i> Mack. | 217 | <i>C. nigromarginata</i> var. |
| 349 | <i>C. cherokeensis</i> Schwein. | | <i>floridana</i> (Schwein.) Kükenth. |
| | | 236 | <i>C. tonsa</i> (Fern.) Bickn. |

SOUTH DAKOTA

- 429 *C. bella* Bailey

TENNESSEE

- | | | | |
|-----|-----------------------------------|-------------------|---|
| 331 | <i>C. aestivalis</i> M. A. Curtis | 329 | <i>C. davisii</i> Schwein. & Torr. |
| 52 | <i>C. aggregata</i> Mack. | 296a | <i>C. laxiflora</i> var. <i>serrulata</i> Hermann |
| 117 | <i>C. angustior</i> Mack. | 328a | <i>C. oxylepis</i> var. <i>pubescens</i> |
| 527 | <i>C. baileyi</i> Britt. | | J. K. Underw. |
| 349 | <i>C. cherokeensis</i> Schwein. | 247 | <i>C. picta</i> Steud. |
| 80 | <i>C. conjuncta</i> Boott | 330 $\frac{1}{2}$ | <i>C. roanensis</i> Hermann |

TEXAS

- | | | | |
|------|--|-------------------|---------------------------------|
| 495 | <i>C. comosa</i> Boott | 262 $\frac{1}{2}$ | <i>C. muriculata</i> Hermann |
| 475a | (<i>C. crinita</i> var. <i>brevicrinis</i> Fern.) | 19 | <i>C. praegracilis</i> W. Boott |
| 403 | <i>C. glaucescens</i> Ell. | 262 | <i>C. stellata</i> Mack. |
| 166 | <i>C. molesta</i> Mack. | | |

UTAH

- | | | | |
|-------------------|--|-------------------|---|
| 433 | <i>C. atrata</i> L. | 426 $\frac{1}{2}$ | <i>C. pelocarpa</i> Hermann |
| 93 | <i>C. brunnescens</i> (Pers.) Poir. | 511 | <i>C. physocarpa</i> Presl |
| 444a | (<i>C. campylocarpa</i> subsp. <i>affinis</i> Maguire & Holmgren) | 151 | <i>C. praticola</i> Rydb. |
| | | 4 $\frac{1}{2}$ | (<i>C. rachillis</i> Maguire) |
| 254 | <i>C. drummondiana</i> Dewey | 523 | <i>C. retrorsa</i> Schwein. |
| 149 $\frac{1}{2}$ | (<i>C. eastwoodiana</i> Stacey) | 170 | <i>C. straminiformis</i> Bailey |
| 136 | <i>C. illota</i> Bailey | 419 | <i>C. tolmiei</i> Boott |
| 469 $\frac{1}{2}$ | (<i>C. interimus</i> Maguire) | 31 | <i>C. vallicola</i> Dewey |
| 166 | <i>C. misandra</i> R. Br. | 11a | (<i>C. vernacula</i> var. <i>hobsonii</i> Maguire) |
| 424 | <i>C. nelsonii</i> Mack. | | |
| 208 | <i>C. obtusata</i> Lilj. | | |

VIRGINIA

- | | | | |
|-------------------|--|-----|--|
| 288a | (<i>C. abscondita</i> var. <i>rostellata</i> Fern.) | 49 | [<i>C. grvida</i> Bailey]—Delete report. |
| 330 | <i>C. aestivaliformis</i> Mack. | | |
| 52 | <i>C. aggregata</i> Mack. | 81 | <i>C. kobomugi</i> Ohwi |
| 117 | <i>C. angustior</i> Mack. | 166 | <i>C. molesta</i> Mack. |
| 527 | <i>C. baileyi</i> Britt. | 217 | <i>C. nigromarginata</i> var. <i>floridana</i> (Schwein.) Kükenth. |
| 78 $\frac{1}{2}$ | (<i>C. bayardi</i> Fern.) | | |
| 167 | <i>C. brevior</i> (Dewey) Mack. | 328 | <i>C. oxylepis</i> Torr. & Hook. |
| 379 | <i>C. bushii</i> Mack. | 243 | <i>C. pedunculata</i> Muhl. |
| 119 | <i>C. cephalantha</i> (Bailey) Bickn. | 223 | <i>C. pensylvanica</i> Lam. |
| 312 $\frac{1}{2}$ | (<i>C. corrugata</i> Fern.) | 215 | <i>C. physorhyncha</i> Liebm. |
| 340a | (<i>C. debilis</i> var. <i>intercursa</i> Fern.) | 235 | <i>C. rugosperma</i> Mack. |
| 66 | <i>C. decomposita</i> Muhl. | 236 | <i>C. tonsa</i> (Fern.) Bickn. |
| 289a | (<i>C. digitalis</i> var. <i>asymetrica</i> Fern.) | 234 | <i>C. umbellata</i> Schkuhr |

WASHINGTON

- | | | | |
|-------------------|----------------------------------|-------------------|----------------------------------|
| 155 $\frac{1}{2}$ | (<i>C. constanceana</i> Stacey) | 149 $\frac{1}{2}$ | (<i>C. eastwoodiana</i> Stacey) |
|-------------------|----------------------------------|-------------------|----------------------------------|

WEST VIRGINIA

- | | | | |
|-----|---|-----|-----------------------------|
| 167 | <i>C. brevior</i> (Dewey) Mack. | 298 | <i>C. leptonervia</i> Fern. |
| 120 | <i>C. bromoides</i> Schkuhr | 37 | <i>C. mesochorea</i> Mack. |
| 93a | <i>C. canescens</i> var. <i>disjuncta</i> Fern. | 164 | <i>C. normalis</i> Mack. |
| 464 | <i>C. emoryi</i> Dewey | 487 | <i>C. pauciflora</i> L. |
| 259 | <i>C. eburnea</i> Boott | 297 | <i>C. striatula</i> Michx. |
| 108 | <i>C. incomperata</i> Bickn. | | |

WISCONSIN

- | | | | |
|-------------------|----------------------------|-----|-----------------------------|
| 285 | <i>C. careyana</i> Torr. | 501 | <i>C. laeviconica</i> Dewey |
| 271 $\frac{1}{2}$ | <i>C. garberi</i> Fern. | 211 | <i>C. peckii</i> Howe |
| 222 | <i>C. heliophila</i> Mack. | | |

WYOMING

- | | | | |
|-----|------------------------------|-------------------|----------------------------------|
| 254 | <i>C. drummondiana</i> Dewey | 149 $\frac{1}{2}$ | (<i>C. eastwoodiana</i> Stacey) |
|-----|------------------------------|-------------------|----------------------------------|

Canada

- | | | | |
|---------------------|--|-------------------|---|
| 421 | <i>C. aboriginum</i> M. E. Jones | 510a | (<i>C. miliaris</i> var. <i>ungavensis</i> Raymond) |
| 437 $\frac{1}{4}$ | (<i>C. adelostema</i> Krecz.) | 100a | (X <i>C. manganinsularum</i> Raymond) |
| 88 $\frac{1}{2}$ | (<i>C. amblyorhyncha</i> Krecz.) | 437 $\frac{1}{2}$ | (<i>C. morrisseyi</i> Raymond) |
| 88 $\frac{1}{2}$ a | (<i>C. amblyorhyncha</i> ssp. <i>pseudolagopina</i> (T. Sørensen) Böcher) | 457c | (X <i>C. nearctica</i> Raymond) |
| 3 $\frac{1}{2}$ | <i>C. arctogena</i> H. Smith | 413a | (<i>C. norvegica</i> var. <i>inserrulata</i> (Kalela) Raymond) |
| 364a | (<i>C. atrofusca</i> var. <i>decolorata</i> Porsild) | 476 | <i>C. paleacea</i> var. <i>transatlantica</i> Fern. |
| 437a | (<i>C. buxbaumii</i> var. <i>anticostensis</i> Raymond) | 371 | <i>C. pallescens</i> var. <i>neogaea</i> Fern. |
| 437b | (<i>C. buxbaumii</i> f. <i>pedunculata</i> Raymond) | 361 | (<i>C. petricosa</i> var. <i>edwardsii</i> Boivin) |
| 347a | (<i>C. capillaris</i> var. <i>porsildiana</i> Polunin) | 416a | (<i>C. podocarpa</i> f. <i>pallidior</i> Lepage) |
| 181a | (<i>C. cumulata</i> f. <i>soluta</i> Fern.) | 404a | (<i>C. rariflora</i> var. <i>androgyna</i> Porsild) |
| 362 $\frac{1}{2}$ | (<i>C. distichiflora</i> Boivin) | 404b | (<i>C. rariflora</i> f. <i>erecta</i> Polunin) |
| 16 $\frac{1}{2}$ | (<i>C. dutillyi</i> O'Neill & Duman) | 434 $\frac{1}{2}$ | <i>C. raymondii</i> Calder |
| 2 $\frac{1}{2}$ | (<i>C. elynaefornis</i> Porsild) | 520a | (<i>C. rostrata</i> var. <i>anticostensis</i> Fern.) |
| 362a | (<i>C. franklinii</i> var. <i>nicholsonis</i> Boivin) | 512a | (<i>C. saxatilis</i> var. <i>laxa</i> Ohwi) |
| 271 $\frac{1}{2}$ | <i>C. garberi</i> Fern. | 476a | (X <i>C. saxeni</i> Raymond) |
| 271 $\frac{1}{2}$ a | <i>C. garberi</i> var. <i>bifaria</i> Fern. | 358a | (X <i>C. sanayi</i> Raymond) |
| 442 | <i>C. gymnoclada</i> Holm | 124 $\frac{1}{2}$ | (<i>C. soperi</i> Raup) |
| 437 1/3 | (<i>C. hartmani</i> Caj.) | 110a | (<i>C. sterilis</i> var. <i>rousseauiana</i> Raymond) |
| 529b | (<i>C. intumescens</i> var. <i>fernaldii</i> f. <i>ventricosa</i> Fern.) | 139 | <i>C. subfusca</i> W. Boott |
| 529c | (X <i>C. joseph-schmitti</i> Raymond) | 256 $\frac{1}{2}$ | (<i>C. terrae-novae</i> Fern.) |
| 14 $\frac{1}{2}$ | (<i>C. langeana</i> Fern.) | 515a | (<i>C. vesicaria</i> f. <i>fluitans</i> Raymond) |
| 384a | (<i>C. lanuginosa</i> var. <i>oriens</i> Raymond) | 354a | (<i>C. viridula</i> f. <i>clandestina</i> Raymond) |
| 457b | (X <i>C. limula</i> Fries) | 354c | (<i>C. viridula</i> f. <i>rousseauiana</i> (Vict.) Raymond) |
| 363 $\frac{1}{2}$ | (<i>C. magnursiana</i> Raymond) | | |

ALBERTA

- | | | | |
|-------------------|---|-------------------|------------------------------|
| 188 | <i>C. cristatella</i> Britt. | 62 | <i>C. prairea</i> Dewey |
| 205 | <i>C. filifolia</i> Nutt. | 434 $\frac{1}{2}$ | <i>C. raymondii</i> Calder |
| 271 $\frac{1}{2}$ | <i>C. garberi</i> var. <i>bifaria</i> Fern. | 229 | <i>C. rossii</i> Boott |
| 129 | <i>C. macloviana</i> Urv. | 64 | <i>C. vulpinoidea</i> Michx. |
| 14 | <i>C. maritima</i> Gunner | | |

BRITISH COLUMBIA

- | | | | |
|---------------------|---|-----|-----------------------------|
| 421 | <i>C. aboriginum</i> M. E. Jones | 125 | <i>C. microptera</i> Mack. |
| 22 | <i>C. foenea</i> Willd. | 350 | <i>C. sprengelii</i> Dewey |
| 271 $\frac{1}{2}$ a | <i>C. garberi</i> var. <i>bifaria</i> Fern. | 139 | <i>C. subfusca</i> W. Boott |
| 442 | <i>C. gymnoclada</i> Holm | 186 | <i>C. tribuloides</i> Wahl. |
| 447 | <i>C. lenticularis</i> Michx. | | |

FRANKLIN DISTRICT

- 88 $\frac{1}{2}$ (*C. amblyorhyncha* ssp. *pseudolagopina* (T. Sørensen) Böcher)

KEEWATIN

- 88 $\frac{1}{2}$ (C. amblyorhyncha Krecz.) 347a (C. capillaris var. porsildiana
88 $\frac{1}{2}$ a (C. amblyorhyncha ssp. pseudo- Polunin)
lagopina (T. Sørensen) Böcher)

LABRADOR

- 437 $\frac{1}{4}$ (C. adelostema Krecz.) 437 $\frac{1}{2}$ (C. morrisseyi Porsild)
3 $\frac{1}{2}$ C. arctogena H. Smith

MACKENZIE DISTRICT

- 88 $\frac{1}{2}$ (C. amblyorhyncha Krecz.) 362a (C. franklinii var. nicholsonis
88 $\frac{1}{2}$ a (C. amblyorhyncha ssp. pseudo- Boivin)
lagopina (T. Sørensen) Böcher) 434 $\frac{1}{2}$ C. raymondii Calder
364a (C. atrofusca var. decolorata 124 $\frac{1}{2}$ (C. soperi Raup)
Porsild) 437 $\frac{1}{2}$ (C. morrisseyi Porsild)
2 $\frac{1}{2}$ (C. elynaeformis Porsild)

MANITOBA

- 88 $\frac{1}{2}$ (C. amblyorhyncha Krecz.) 16 $\frac{1}{2}$ (C. dutillyi O'Neill & Duman)
181 C. cumulata Mack. 434 $\frac{1}{2}$ C. raymondii Calder

NEW BRUNSWICK

- 271 $\frac{1}{2}$ a C. garberi var. bifaria Fern.

NEWFOUNDLAND

- 529b (C. intumescens var. fernaldii 14 $\frac{1}{2}$ (C. langeana Fern.)
f. ventricosa Fern.) 256 $\frac{1}{2}$ (C. terrae-novae Fern.)

NORTHWEST TERRITORIES

- 362 $\frac{1}{2}$ (C. distichiflora Boivin) 404a (C. rariflora var. androgyna
363 $\frac{1}{2}$ (C. magnursiana Raymond) Porsild)
361a (C. petricosa var. edwardsii Boivin)

NOVA SCOTIA

- 181a (C. cumulata f. soluta Fern.)

ONTARIO

- 88 $\frac{1}{2}$ (C. amblyorhyncha Krecz.) 404 C. rariflora (Wahl.) J. E. Sm.
364 C. atrofusca Schkuhr 479 C. subspathacea Wormsk.
271 $\frac{1}{2}$ C. garberi Fern.

QUEBEC

- 437 $\frac{1}{4}$ (C. adelostema Krecz.) 520a (C. rostrata var. anticostensis
437a (C. buxbaumii var. anticostensis Fern.)
Raymond) 512a (C. saxatilis var. laxa Ohwi)
437b (C. buxbaumii f. pedunculata 110a (C. sterilis var. rousseauiana
Raymond) Raymond)
271 $\frac{1}{2}$ a C. garberi var. bifaria Fern. 515a (C. vesicaria f. fluitans Raymond)
437 1/3 (C. hartmani Caj.) 354a (C. viridula f. clandestina
Raymond)
384a (C. lanuginosa var. oriens 354c (C. viridula f. rousseauiana
Raymond) (Vict.) Raymond)
510a (C. miliaris var. ungavensis Raymond)

SASKATCHEWAN

- 271 $\frac{1}{2}$ a C. garberi var. bifaria Fern. 496 C. pseudo-cyperus L.
499 C. lacustris Willd. 434 $\frac{1}{2}$ C. raymondii Calder
211 C. peckii Howe

YUKON

- 416a (C. podocarpa f. pallidior Lepage) 434 $\frac{1}{2}$ C. raymondii Calder

Alaska

- | | | | |
|-----------|--|-----------|---|
| 364b | (<i>C. atrofusca</i> var. <i>nortoniana</i> Boivin) | 363 1/3 | (<i>C. lepageana</i> Raymond) |
| 224 | <i>C. concinna</i> R. Br. | 92 | <i>C. mackenziei</i> Krecz. |
| 433 1/2 | (<i>C. enanderi</i> Hultén) | 518 1/2 | (<i>C. melozitnensis</i> Porsild) |
| 271 1/2 a | <i>C. garberi</i> var. <i>bifaria</i> Fern. | 404 1/2 | (<i>C. pluriflora</i> Hultén) |
| 1 1/2 | (<i>C. jacobi-petri</i> Hultén) | 479 1/2 | (<i>C. ramenskii</i> Komarov) |
| 450 1/2 | (<i>C. kokrinensis</i> Porsild) | 479 1/2 a | (<i>C. ramenskii</i> var. <i>caudata</i> Hultén) |

Aleutian Islands

- | | | | |
|-------|--|-------|--|
| 422 | <i>C. gmelini</i> Hook. & Arn. | 477 a | (<i>C. lyngbyei</i> subsp. <i>cryptocarpa</i> f. <i>gigas</i> Hultén) |
| 273 a | <i>C. livida</i> var. <i>grayana</i> Fern. | | |

Mexico

- | | | | |
|---------|----------------------------------|---------|----------------------------------|
| 303 1/2 | <i>C. atractodes</i> Hermann | 203 1/2 | <i>C. longissima</i> M. E. Jones |
| 391 1/2 | (<i>C. ballsii</i> Nelves) | 324 1/2 | <i>C. mackenziana</i> Weatherby |
| 429 | <i>C. bella</i> Bailey | 58 1/2 | <i>C. percostata</i> Hermann |
| 166 1/2 | <i>C. diehlii</i> M. E. Jones | 483 | <i>C. ultra</i> Bailey |
| 169 1/2 | <i>C. lagunensis</i> M. E. Jones | 31 | <i>C. vallicola</i> Dewey |

BAJA CALIFORNIA

- | | | | |
|---------|-----------------------------------|---------|----------------------------------|
| 169 1/2 | <i>C. lagunensis</i> M. E. Jones. | 203 1/2 | <i>C. longissima</i> M. E. Jones |
|---------|-----------------------------------|---------|----------------------------------|

CHIAPAS

- | | | | |
|---------|------------------------------|-----|----------------------------|
| 303 1/2 | <i>C. atractodes</i> Hermann | 392 | <i>C. chordalis</i> Liebm. |
|---------|------------------------------|-----|----------------------------|

CHIHUAHUA

- | | | | |
|---------|-------------------------------|--------|------------------------------|
| 166 1/2 | <i>C. diehlii</i> M. E. Jones | 58 1/2 | <i>C. percostata</i> Hermann |
|---------|-------------------------------|--------|------------------------------|

COAHUILA

- | | | | |
|-----|-----------------------------|-----|--------------------------|
| 203 | <i>C. arsensii</i> Kükenth. | 262 | <i>C. stellata</i> Mack. |
|-----|-----------------------------|-----|--------------------------|

GUERRERO

- | | | | |
|-----|-------------------------------|--------|------------------------------|
| 264 | <i>C. humboldtiana</i> Steud. | 58 1/2 | <i>C. percostata</i> Hermann |
|-----|-------------------------------|--------|------------------------------|

JALISCO

- | | |
|-----|----------------------------|
| 392 | <i>C. chordalis</i> Liebm. |
|-----|----------------------------|

STATE OF MEXICO

- | | |
|----|---------------------------|
| 31 | <i>C. vallicola</i> Dewey |
|----|---------------------------|

NUEVO LEON

- | | | | |
|-----|---------------------------------|-----|------------------------------|
| 429 | <i>C. bella</i> Mack. | 253 | <i>C. planostachys</i> Kunze |
| 92 | <i>C. mackenziana</i> Weatherby | 483 | <i>C. ultra</i> Bailey |

OAXACA

- | | |
|-----|-----------------------------|
| 318 | <i>C. longicaulis</i> Bock. |
|-----|-----------------------------|

PUEBLA

- | | | | |
|-----|-----------------------------|----|----------------------------|
| 318 | <i>C. longicaulis</i> Bock. | 42 | <i>C. xalapensis</i> Kunth |
| 218 | <i>C. turbinata</i> Liebm. | | |

TAMAULIPAS

- | | | | |
|-----|----------------------------|-----|------------------------------|
| 219 | <i>C. leucodonta</i> Holm | 253 | <i>C. planostachys</i> Kunze |
| 260 | <i>C. perstricta</i> Mack. | | |

VERA CRUZ

- | | | | |
|---------|-------------------------------|-----|-----------------------------|
| 317 | <i>C. anisostachys</i> Liebm. | 318 | <i>C. longicaulis</i> Bock. |
| 391 1/2 | (<i>C. ballsii</i> Nelves) | | |

Central America

- | | |
|--|---|
| 265 $\frac{1}{2}$ (C. bartlettii O'Neill) | 303 $\frac{1}{3}$ C. quichensis Hermann |
| 393 C. cortesii Liebm. | 263 $\frac{1}{2}$ (C. standleyana Steyermark) |
| 324 $\frac{1}{3}$ (C. huehuetica Steyermark) | 324 $\frac{1}{4}$ (C. steyermarkii Standley) |

BRITISH HONDURAS

- 265 $\frac{1}{2}$ (C. bartlettii O'Neill)

COSTA RICA

- 393 C. cortesii Liebm.

GUATEMALA

- | | |
|--|---|
| 324 $\frac{1}{3}$ (C. huehuetica Steyermark) | 263 $\frac{1}{2}$ (C. standleyana Steyermark) |
| 303 $\frac{1}{3}$ C. quichensis Hermann | 324 $\frac{1}{4}$ (C. steyermarkii Standley) |

HONDURAS

- 263 $\frac{1}{2}$ (C. standleyana Steyermark)

Variation and Subspeciation in the Common Sunflower, *Helianthus annuus*

Charles B. Heiser, Jr.

Indiana University, Bloomington

An understanding of the origin of our cultivated plants obviously requires a knowledge of the plant's wild ancestors. Unfortunately the wild ancestors of many of our cultivated crop plants are not known and in all likelihood are extinct. The sunflower, however, is a significant exception, for the common sunflower is a wide ranging species throughout much of North America. In cultivation it is known throughout the world. It has long been recognized as a highly variable species and previously three main taxa have been recognized (Heiser, 1951c)—*H. annuus* var. *lenticularis*, the so-called wild form of western North America; *H. annuus* var. *annuus*, the ruderal sunflower primarily of the central United States; and *H. annuus* var. *macrocarpus*, the forms cultivated for their oily seeds.

In the present paper an attempt will be made to analyze some of the wild and weed forms of the sunflower with emphasis being placed upon their variation, taxonomy, and probable evolution. A number of cultivated strains have been examined previously and preliminary remarks concerning the origin of the cultivated sunflower have been published (Heiser, 1951c). Archaeological material of the sunflower has been studied but these data have not as yet been published. After detailed considerations of the archaeological sunflowers, the cultivated races in existence today, and the wild and weed forms, we should have a fairly complete knowledge of the origin of the cultivated sunflower.

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METHODS

Seeds of *H. annuus* were collected by the writer and others (see Acknowledgments) throughout most of the range of the species. Unfortunately, not all regions are equally well represented but the examination of herbarium material indicates that a fairly accurate sample of the variability of the species as a whole is contained within these samples. Plants from these seeds have been grown in experimental gardens at Davis, California, in 1947 (the "D" series in table 1), and at Bloomington, Indiana, in 1949, 1950, and 1951.

The seeds were planted at the same time every spring and after a two-weeks cold treatment were allowed to germinate in the greenhouse, then transplanted to the field. The plants were irrigated at Davis and non-irrigated at Bloomington.

TABLE 1.—Ray number and disk diameter in experimental garden populations of *Helianthus annuus*

| Number | Locality | n | Ray Number | | | Disk Diameter | | |
|---------|-----------------------|----|------------|------|----|---------------|------|----|
| | | | X | s | V | X | s | V |
| D30 | Whitman Co., Wash. | 3 | 23.0 | 4.3 | 19 | 3.43 | .31 | 9 |
| D29 | Benton Co., Wash. | 5 | 24.4 | 6.8 | 28 | 4.38 | .88 | 20 |
| 5101 | Chelan Co., Wash. | 25 | 27.2 | 5.8 | 21 | 3.52 | .22 | 13 |
| 5102 | Malheur Co., Ore. | 18 | 21.5 | 3.6 | 16 | 2.71 | .36 | 14 |
| D18 | Yolo Co., Cal. | 7 | 18.1 | 1.9 | 10 | 1.94 | .15 | 8 |
| 5003 | Yolo Co., Cal. | 27 | 21.4 | 2.3 | 11 | 2.23 | .32 | 14 |
| D42 | Yolo Co., Cal. | 7 | 29.0 | 12.9 | 44 | 3.79 | 2.26 | 60 |
| 5004 | Yolo Co., Cal. | 24 | 34.8 | 3.9 | 11 | 5.85 | .66 | 11 |
| 5106 | San Joaquin Co., Cal. | 23 | 25.3 | 4.3 | 17 | 2.90 | .32 | 11 |
| D24 | San Benito Co., Cal. | 10 | 17.7 | 1.8 | 10 | 2.45 | .40 | 16 |
| 5105 | Tulare Co., Cal. | 20 | 16.9 | 3.0 | 18 | 2.11 | .28 | 13 |
| 5008 | Los Angeles Co., Cal. | 17 | 22.7 | 4.8 | 21 | 2.63 | .44 | 17 |
| 5007 | Los Angeles Co., Cal. | 4 | 16.3 | 2.7 | 17 | 2.15 | .12 | 6 |
| 4955 | Imperial Co., Cal. | 8 | 20.3 | 2.9 | 14 | 2.74 | .32 | 12 |
| D31 | Nez Perce Co., Ida. | 10 | 16.8 | 1.0 | 6 | 2.83 | .41 | 14 |
| 5107 | Elmore Co., Ida. | 15 | 25.5 | 4.8 | 19 | 2.52 | .43 | 17 |
| 5108 | Nez Perce Co., Ida. | 17 | 18.7 | 3.6 | 19 | 2.28 | .39 | 17 |
| 5109 | Utah Co., Utah | 25 | 24.1 | 4.4 | 18 | 3.10 | .32 | 10 |
| 5110a | Grand Co., Utah | 11 | 19.8 | 2.7 | 13 | 2.18 | .31 | 14 |
| 4952 | Coconino Co., Ariz. | 8 | 20.1 | 0.8 | 4 | 2.55 | .32 | 13 |
| D32 | Larimer Co., Colo. | 3 | 22.0 | 2.6 | 12 | 3.40 | .36 | 11 |
| 5112 | Prowers Co., Colo. | 24 | 24.0 | 3.4 | 14 | 3.05 | .25 | 8 |
| 5112a | Cheyenne Co., Colo. | 23 | 26.4 | 4.8 | 18 | 2.73 | .39 | 14 |
| 5113 | Fremont Co., Colo. | 23 | 28.2 | 3.8 | 13 | 2.79 | .36 | 13 |
| 5115 | Boulder Co., Colo. | 24 | 22.0 | 3.0 | 14 | 2.98 | .33 | 11 |
| 5115a | Chaffee Co., Colo. | 6 | 18.2 | 5.8 | 32 | 2.40 | .39 | 16 |
| 5116 | Montrose Co., Colo. | 24 | 23.0 | 4.3 | 19 | 2.96 | .38 | 13 |
| 5117 | Mesa Co., Colo. | 18 | 23.6 | 4.8 | 20 | 3.08 | .31 | 10 |
| 5118 | Rio Blanco Co., Colo. | 24 | 12.9 | 4.5 | 35 | 1.88 | .54 | 29 |
| 5118a | Garfield Co., Colo. | 7 | 21.3 | 1.6 | 7 | 2.83 | .14 | 5 |
| 5119 | Alamosa Co., Colo. | 23 | 9.6 | 4.0 | 42 | 1.59 | .50 | 32 |
| 5121 | Dolores Co., Colo. | 21 | 23.1 | 4.7 | 20 | 2.62 | .42 | 16 |
| 5011 | Pecos Co., Tex. | 23 | 20.7 | 3.1 | 15 | 2.57 | .32 | 12 |
| 5012 | Potter Co., Tex. | 13 | 21.8 | 2.4 | 11 | 2.93 | .35 | 12 |
| f Tex b | Comal Co., Tex. | 17 | 19.6 | 1.8 | 9 | 2.55 | .23 | 9 |
| D38 | Zavala Co., Tex. | 10 | 18.0 | 1.6 | 9 | 2.48 | .32 | 13 |
| 5014 | Cameron Co., Tex. | 25 | 19.4 | 2.6 | 13 | 2.34 | .24 | 10 |
| 5016 | Brazos Co., Tex. | 20 | 32.8 | 5.9 | 18 | 3.17 | .44 | 14 |
| 5017 | DeWitt Co., Tex. | 13 | 19.3 | 1.7 | 9 | 2.23 | .31 | 14 |
| f Tex c | Dimmit Co., Tex. | 9 | 18.7 | 1.7 | 9 | 2.18 | .28 | 13 |
| f Tex d | Lee Co., Tex. | 12 | 24.1 | 3.9 | 16 | 2.59 | .17 | 7 |
| f Tex e | Harris Co., Tex. | 9 | 22.3 | 3.1 | 14 | 2.79 | .19 | 7 |
| 5019 | Matagorda Co., Tex. | 10 | 21.5 | 2.4 | 11 | 2.41 | .18 | 7 |
| D40 | Chihuahua, Mex. | 3 | 20.7 | 3.2 | 15 | 2.80 | .26 | 9 |
| D36 | Burleigh Co., N. D. | 6 | 19.8 | 1.7 | 9 | 3.00 | .50 | 17 |
| 5032 | Burleigh Co., N. D. | 15 | 23.9 | 4.6 | 19 | 3.41 | .56 | 16 |
| 4942 | Sanborn Co., S. D. | 8 | 25.1 | 4.1 | 16 | 3.74 | .22 | 6 |
| 5126 | Pennington Co., S. D. | 13 | 18.2 | 4.3 | 24 | 2.48 | .72 | 29 |
| 4944 | Buffalo Co., Nebr. | 8 | 27.4 | 5.9 | 22 | 3.69 | .48 | 13 |

TABLE 1.—(continued)

| Number | Locality | n | Ray Number | | | Disk Diameter | | |
|--------|-----------------------|----|------------|------|----|---------------|------|----|
| | | | X | s | V | X | s | V |
| 4945 | Sherman Co., Nebr. | 11 | 29.5 | 4.4 | 15 | 3.70 | .59 | 16 |
| 5024 | Lancaster Co., Nebr. | 15 | 32.6 | 1.9 | 6 | 3.95 | .40 | 10 |
| 5025 | Harper Co., Kan. | 25 | 32.4 | 4.6 | 14 | 3.64 | .32 | 9 |
| 5026 | Ford Co., Kan. | 6 | 26.8 | 3.8 | 14 | 3.12 | .35 | 11 |
| 5123 | Osborne Co., Kan. | 23 | 29.2 | 4.6 | 16 | 3.48 | .27 | 8 |
| 5125 | Sheridan Co., Kan. | 25 | 22.4 | 2.4 | 11 | 3.04 | .41 | 13 |
| 5028 | Lincoln Co., Kan. | 18 | 30.6 | 4.5 | 15 | 3.98 | .36 | 9 |
| 5029b | Leavenworth Co., Kan. | 9 | 28.0 | 5.6 | 20 | 3.73 | .32 | 9 |
| 5021 | Pittsburgh Co., Okla. | 17 | 22.4 | 2.9 | 13 | 2.99 | .29 | 10 |
| 4938 | Hennepin Co., Minn. | 8 | 32.4 | 4.4 | 14 | 4.33 | .58 | 13 |
| 5038 | Olmsted Co., Minn. | 27 | 45.3 | 12.6 | 28 | 6.10 | 1.42 | 23 |
| 4941 | Polk Co., Iowa | 8 | 27.5 | 3.1 | 11 | 3.33 | .86 | 26 |
| 5034 | Atchinson Co., Mo. | 12 | 32.8 | 4.1 | 13 | 3.99 | .33 | 8 |
| 5035 | Saline Co., Mo. | 22 | 35.7 | 3.9 | 11 | 3.86 | .37 | 10 |
| 5036 | Clinton Co., Mo. | 26 | 34.0 | 1.6 | 5 | 4.09 | .99 | 24 |
| 5037 | St. Louis, Mo. | 18 | 30.7 | 4.7 | 15 | 3.95 | .53 | 13 |
| D45 | St. Clair Co., Ill. | 6 | 21.5 | 5.7 | 23 | 2.85 | .34 | 11 |
| 5041 | Marion Co., Ind. | 10 | 33.3 | 2.9 | 9 | 3.70 | .49 | 13 |
| 5040 | Marion Co., Ind. | 25 | 36.0 | 6.7 | 19 | 4.87 | .66 | 14 |
| 5129 | Monroe Co., Ind. | 15 | 39.7 | 8.0 | 20 | 5.67 | .58 | 10 |
| P88 | Shelby Co., Tenn. | 8 | 32.1 | 1.7 | 5 | 3.96 | .38 | 10 |
| 5042 | Paulding Co., Ohio | 16 | 33.1 | 3.3 | 10 | 3.91 | .59 | 15 |
| D37 | Suffolk Co., Mass. | 8 | 25.1 | 4.7 | 19 | 3.34 | .57 | 17 |
| 5044 | Pitt Co., N. C. | 13 | 36.5 | 4.2 | 12 | 5.51 | .62 | 11 |
| 5045 | Holmes Co., Fla. | 20 | 38.3 | 7.1 | 19 | 5.01 | .42 | 8 |
| AA12 | "Mammoth Russian" | 17 | 51.6 | 3.7 | 7 | 11.78 | 1.39 | 12 |
| *5250 | Citrus Co., Fla. | 16 | 24.8 | 4.9 | 20 | 3.2 | .37 | 12 |
| 5251 | Cook Co., Ill. | 16 | 30.4 | 3.6 | 12 | 3.6 | .32 | 9 |
| 5252 | Coconino Co., Ariz. | 16 | 28.5 | 5.6 | 20 | 3.4 | .46 | 13 |
| 5253 | Coconino Co., Ariz. | 16 | 20.9 | 4.6 | 22 | 2.6 | .40 | 15 |
| 5254 | Colfax Co., N. Mex. | 14 | 20.3 | 2.6 | 13 | 3.0 | .44 | 15 |
| 5255 | Valencia Co., N. Mex. | 32 | 20.9 | 3.3 | 16 | 2.9 | .39 | 14 |
| 5257 | Hall Co., Tex. | 15 | 21.2 | 2.5 | 12 | 3.1 | .52 | 17 |

* The last seven populations were grown in 1952 and are not included on the map (fig. 1).

Counts of rays and measurements of disk diameters were made on terminal heads on the morning of the anthesis of the outermost row of disk flowers. The number of rays and the diameter of the disk are readily and accurately scored and measured, and show considerable variability. For these reasons the data concerning them are presented in some detail. Achene measurements were made on the original seed samples, but because of various difficulties they were not made on the plants grown from these seeds in the experimental garden. Anther color was scored in the field on all plants grown in 1951 and 1952, and the scoring of the plants of the previous years was done from herbarium specimens, three or more of which had been preserved for each garden population. Certain other characteristics such as blooming dates, ray color, height, degree of pubescence were also recorded or scored in the field.

The cultivation of plants in the experimental garden was undertaken in order to study the heritable differences in the plants from various regions and to eliminate, insofar as possible, the effects of environmental modification. An important question arising in this connection with the study is whether

the populations grown in the experimental garden are similar to those found in nature. Mass collections from seven localities in nature* have been made and the disk diameters and ray numbers of these population samples are given in table 2 with the same data on the experimental garden population from the same region for comparison. Examination of the table shows that the disagreements between means for two populations from the same region are very slight. The close similarity is all the more remarkable because the measurements of the natural populations are made on whatever heads are in flower and consequently terminal heads are not always selected.

TABLE 2.—Comparison of variation in ray number and disk diameter of *Helianthus annuus* from natural and experimental garden populations*

| Accession Number | Locality | n | Ray Number | | | Disk Diam. in cm. | | |
|------------------|-----------------------|----|------------|-----|----|-------------------|-----|----|
| | | | X | s | V | X | s | V |
| 1856 | San Joaquin Co., Cal. | 16 | 19.1 | 1.9 | 10 | 2.93 | .20 | 7 |
| D20 | Yolo Co., Cal. | 6 | 21.2 | 2.2 | 10 | 2.98 | .44 | 14 |
| 1825 | Los Angeles Co., Cal. | 19 | 20.5 | 1.9 | 9 | 3.07 | .27 | 9 |
| 4954 | Los Angeles Co., Cal. | 8 | 21.1 | 3.8 | 18 | 2.44 | .62 | 25 |
| 3085 | Harris Co., Tex. | 10 | 20.6 | 1.3 | 6 | 2.84 | .18 | 6 |
| f Tex e | Harris Co., Tex. | 9 | 22.3 | 3.1 | 14 | 2.79 | .19 | 7 |
| 3077 | Matagorda Co., Tex. | 10 | 21.2 | 1.5 | 7 | 2.85 | .17 | 6 |
| 5019 | Matagorda Co., Tex. | 10 | 21.5 | 2.4 | 11 | 2.41 | .18 | 7 |
| 1791 | St. Louis Mo. | 23 | 31.3 | 4.8 | 15 | 4.10 | .61 | 15 |
| D44 | St. Louis, Mo. | 8 | 31.8 | 7.5 | 24 | 4.24 | .26 | 6 |
| 3110 | Marion Co., Ind. | 5 | 32.2 | 2.2 | 7 | 4.28 | .52 | 12 |
| 5040 | Marion Co., Ind. | 25 | 36.0 | 6.7 | 19 | 4.87 | .66 | 14 |

* The natural populations are given first from each locality and are followed by an experimental garden population, seeds of which were collected in the same or a nearby area.

However, certain populations from the west do not present the same appearance in the experimental garden as they did in the wild. At Davis, populations grown from seed from Cass County, North Dakota, produced stunted plants from six inches to two feet in height with correspondingly small heads and few rays and leaves with truncate instead of the normal cordate bases. In addition, these plants bloomed earlier than those from any other locality. The same situation held at Bloomington for populations from Regina and Swift Current, Saskatchewan; Webb, Manitoba; Kern County, California; Alamosa (5119) and Rio Blanco County (5118), Colorado; and one population from Coconino County, Arizona. Some of the original specimens from which the seeds were derived for these populations were available for study and were found to be more nearly normal, i.e., taller and with larger disks and more rays, than the plants grown in the experimental garden.

The ray and disk measurements of the two Colorado populations (5119 and 5118) are included in table 1. The low ray number (13 and 10) and the small disk diameters (1.8 and 1.6 cm.) in both of these are strikingly

* The mass collections are probably fairly random samples except for the fact that depauperate individuals were not collected.

different from all other populations, and even more striking is the high variability of both of these characters. Such high variability is frequently caused by hybridization but there was no morphological evidence of mongrel ancestry in these populations. The plants started to bloom in June, earlier than plants from any other region, and some individuals continued to bloom into July. The plants blooming at the later dates were similar to plants from other populations of sunflowers from Colorado. Unfortunately no natural population samples from either region are available. Many herbarium specimens from Colorado and other places in the west which are similar to the dwarf plants of these populations have been examined. These had been simply regarded as depauperate forms which had been modified by the environment, but the decision as to whether this is the true explanation will have to await further study. The behavior of these plants in the experimental garden, however, apparently reflects genetic differences of some sort. Seeds for many of the

TABLE 3.—Comparison of ray number and disk diameter of *Helianthus annuus* from experimental garden populations grown in different years at Davis, Cal., and Bloomington, Ind.*

| Number | Locality | n | Ray Number | | | Disk Diameter | | |
|--------|-----------------------|----|------------|-----|----|---------------|-----|----|
| | | | X | s | V | X | s | V |
| D20 | Yolo Co., Cal. | 6 | 21.2 | 2.2 | 10 | 2.98 | .44 | 14 |
| 5003 | Yolo Co., Cal. | 27 | 21.4 | 2.3 | 11 | 2.23 | .32 | 14 |
| D46 | Yolo Co., Cal. | 8 | 34.8 | 8.2 | 24 | 4.93 | .86 | 17 |
| 5004 | Yolo Co., Cal. | 24 | 34.8 | 3.9 | 11 | 5.85 | .66 | 11 |
| D25 | Los Angeles Co., Cal. | 11 | 17.9 | 2.5 | 14 | 2.44 | .28 | 11 |
| 4954 | Los Angeles Co., Cal. | 8 | 21.1 | 3.8 | 18 | 2.44 | .62 | 25 |
| 5008 | Los Angeles Co., Cal. | 17 | 22.7 | 4.8 | 21 | 2.63 | .44 | 17 |
| D38 | Zavala Co., Tex. | 10 | 18.0 | 1.6 | 9 | 2.48 | .32 | 13 |
| 4917 | Zavala Co., Tex. | 6 | 19.8 | 1.5 | 8 | 2.75 | .22 | 8 |
| D34 | Sanborn Co., S. D. | 4 | 21.8 | 2.0 | 9 | 2.80 | .22 | 8 |
| 4942 | Sanborn Co., S. D. | 8 | 25.1 | 4.1 | 16 | 3.74 | .22 | 6 |
| 4944 | Buffalo Co., Nebr. | 8 | 27.4 | 5.9 | 22 | 3.69 | .48 | 13 |
| 5023 | Buffalo Co., Nebr. | 5 | 26.6 | 3.3 | 12 | 4.14 | .68 | 16 |
| D44 | St. Louis, Mo. | 8 | 31.8 | 7.5 | 24 | 4.24 | .26 | 6 |
| 4911 | St. Louis, Mo. | 8 | 32.4 | 6.9 | 21 | 4.41 | .84 | 19 |
| 5037 | St. Louis, Mo. | 18 | 30.7 | 4.7 | 15 | 3.95 | .53 | 13 |
| 5128 | St. Louis, Mo. | 9 | 30.4 | 5.2 | 17 | 4.09 | .68 | 17 |
| 4937 | Marion Co., Ind. | 9 | 31.1 | 1.6 | 5 | 3.79 | .56 | 15 |
| 5041 | Marion Co., Ind. | 10 | 33.3 | 2.9 | 9 | 3.70 | .49 | 13 |

* The "D" series was grown at Davis, the "49," "50," and "51" series were grown at Bloomington in 1949, 1950, and 1951 respectively.

abnormal populations were derived from high altitudes and these plants might represent a distinct altitudinal ecotype, but that the explanation is not simply one of altitude is clear from the fact that other plants from even higher altitudes (5115 and 5121, for example) produced apparently normal plants in the garden.*

* Since the above was written plants of 5118 have been grown in the greenhouse, and although a few plants were again of the "abnormal" type, the majority were similar to other western sunflowers when grown under greenhouse conditions.

Other problems confronting us are whether the plants grown at Davis and Bloomington can be directly compared, and also whether the plants grown at Bloomington in different years can be considered together. In table 3 the ray and disk measurements on several populations which have been grown at Davis and Bloomington, and at Bloomington in different years are given. The means show fairly close agreement with one exception (D34 and 4942) and it appears that for present purposes the slight differences can be ignored.

PATTERN OF VARIATION WITHIN THE SPECIES

Anther and disk color.—The disk flowers in *H. annuus* may be either yellow or reddish-purple. Plants with reddish-purple flowers have anthers that are either purple or red, a difference which is usually clear cut in living material but is sometimes obscure in poorly preserved herbarium material. The forms with yellow disk flowers generally have black anthers. As may be seen from the map (fig. 1) and from fig. 2 the red anther color is confined for the most part to the western United States (one plant in 5123 from Kansas had red anthers), whereas purple anther color occurs throughout the range of the species. Black anther color has been found in several populations from the central and eastern areas and in three west coast populations (D42, 5106, and D25). The number of plants in each population with black anthers was generally only one or two although in one Minnesota sample (5038) eleven plants out of twenty-seven had black anthers. The black anther color is also found in many varieties of the cultivated sunflower. A yellow anther color has been seen in a few plants in three populations (not shown on map), two from California (5008 and 5106) and one from Washington (5101) and is associated with disk flowers which have only a very small amount of reddish pigment.

The examination of several hundred herbarium specimens has revealed that the distribution of the anther colors as seen in the experimental populations apparently holds true for the species as a whole—red is confined for the most part to the far west, purple is found throughout the entire range, and black is mainly eastern.

Ray number and disk diameter.—The means of the ray numbers and disk diameters of the populations are given in table 1 and are shown graphically on the map (fig. 1). The number of rays is obviously correlated with the diameter of the disk (fig. 2). Examination of these figures reveals that the western and Texas populations, with only a few exceptions, have a ray number of 26 or less and a disk diameter of 3.0 cm. or less. It can be seen that in general the number of rays and the disk diameters increase as one goes eastward approaching in number and size those of the cultivated sunflower (see last entry in table 1). However, it can also be noted that there are several exceptions to this clinal trend. These are of special interest and are discussed below.*

* Wilcox (1902) in a report on variation in ray numbers in a natural population of *H. annuus* in Oklahoma found in a thousand plants that the ray number varied from 12 to 45; the mode was 21, and 58% of the plants had a ray number of 19 to 23. From my own experiences it seems that the majority of the individuals with the very low number of rays (12-16) represent depauperate individuals which are ecological modifications, and that the occurrence of forms with 35 or more rays is due to the inclusion of "double-flowered" forms which may be either genetic or environmental modifications.

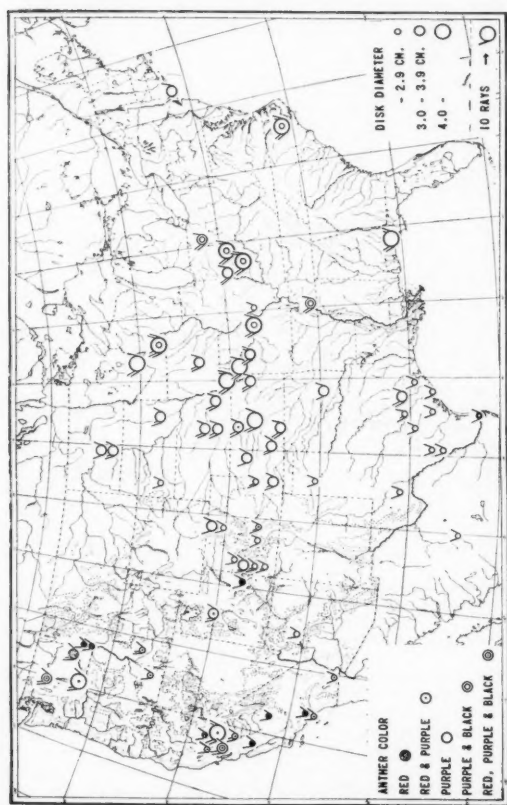


Fig. 1.—Map of *Helianthus annuus* showing source of original collection and anther color, disk diameter, and ray number of the experimental garden populations. The size of the dot roughly denotes the average disk diameter. The ray number is denoted by the bars—each full length bar represents 10 rays, half length bars, 5 rays, etc. The Massachusetts population, for example, had an average ray number of 25. Anther color is denoted by the manner indicated at the lower left of the map. (Base map used through the courtesy of Dr. R. E. Woodson, Jr. and the Missouri Botanical Garden.)

Achene size.—Considerable variation in the achene size occurs within *H. annuus*. The length ranges from slightly over 3 mm. in wild plants to over 17 mm. in certain prehistoric cultivated forms. The length and width of the achenes for the majority of the "samples" listed in table 1 are shown on the scatter diagram (fig. 3). It can be seen from this diagram that the smallest achenes and also those which tend to be widest in relation to their length are found in Texas. Those achenes of intermediate size, and also some of large size which are of suspected hybrid ancestry, are found in the west. In the central and eastern area there is considerable variation although a rather large proportion of the plants have large achenes. In general the achene size is correlated with the size of the disk.

Other characters.—Although only the data pertaining to the ray number, disk diameter, anther color, and achene size are treated in detail here, observations have been made on a number of other characters. Certain of these will be discussed briefly.

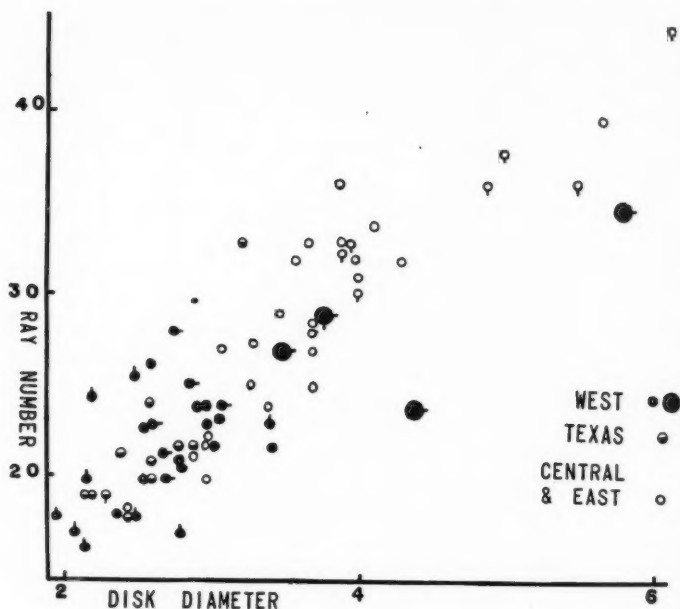


Fig. 2.—Ray number disk diameter, and anther color in *Helianthus annuus*. Each dot denotes the average ray number (vertical axis) and the disk diameter in centimeters (horizontal axis) of the experimental garden populations. Populations with all the plants having red anthers are denoted by the erect bars at the top of the circle; populations having some plants with purple anthers and some with red anthers are denoted by the horizontal bar to the right of the dot; populations having plants with both purple and yellow anthers are denoted by the bar at the base of the dot; and populations with all plants having purple anthers are without bars. The large black dots indicate those western populations of putative hybrid origin between wild and cultivated sunflowers.

In general it appears that the sizes of most of the organs of the plant are strongly correlated, as might be expected, but certain interesting exceptions are found in regard to over-all height of the plant. The plants with small disks are generally short (1 to 1.5 M) and those with the largest disks are generally taller (1.5 to 2 M) but the tallest plants (2.5 to 3.5 M), which come from Kansas, Nebraska, and Missouri, have disks of intermediate size. The height does appear to be strongly correlated with the blooming date (table 4). Under conditions in the experimental garden at Bloomington* where the seeds were planted in the third week of March, plants from Idaho,

* The plants grown in California are not included. All "races" bloomed somewhat earlier in California than in Bloomington. This may be due to the slower growth of the plants in Bloomington during late April and early May.

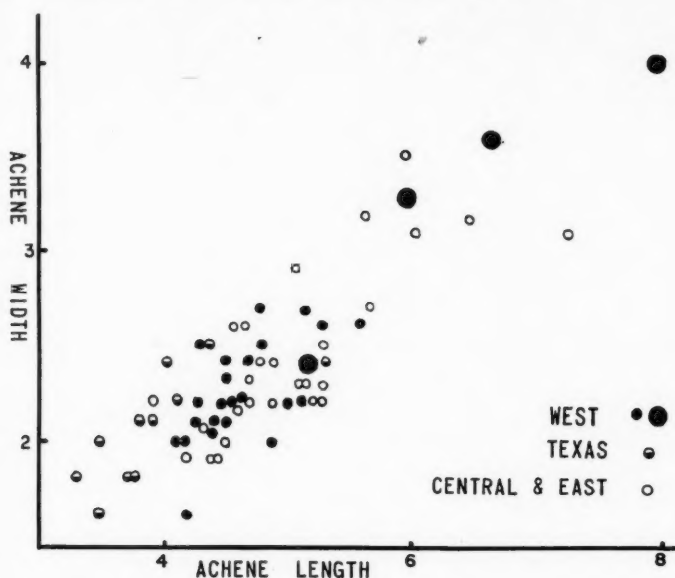


Fig. 3.—Width and length (in millimeters) of *Helianthus annuus* achenes collected in the wild. The large black dots indicate those western populations of putative hybrid origin between wild and cultivated sunflowers.

TABLE 4.—Correlation of height and blooming dates of populations of sunflowers grown at Bloomington, Indiana

| Height in Meters | Number of populations in bloom | | | | | | |
|---------------------|--------------------------------|-----------|------------|------------|-----------|------------|------------|
| | Jun. | Jul. 1-10 | Jul. 11-20 | Jul. 21-31 | Aug. 1-10 | Aug. 11-20 | Aug. 21-30 |
| .5-.7 | 2 | | 2 | | | | |
| .8-1.0 | 3 | 3 | 4 | | | | |
| 1.1-1.3 | 1 | 6 | 7 | | | | |
| 1.4-1.6 | | 3 | 9 | 3 | | 1 | |
| 1.7-2.0 | | 1 | 3 | 2 | 1 | 1 | |
| 2.1-2.4 | | | | 1 | 3 | 2 | |
| 2.5-3.4 | | | | | | 1 | 2 |

South Dakota, and Colorado bloomed in June, plants from California, Texas, and Colorado in early July, plants from Iowa, Nebraska, Missouri, Indiana, North Carolina, and Florida bloomed in mid or late August. Also of interest in this connection is the fact that the blooming dates show no strong north-south correlation. Plants from the northern regions as well as those from Texas were generally early to bloom whereas many of those in the intermediate area were late in blooming. To what extent the blooming dates in the experimental garden are similar to those in nature is not known.

Certain other characters also show considerable variation, but if any geographical trend is present it is difficult to detect. The degree of pubescence of the involucre bracts is a good example. A given population may be characterized by bracts with almost glabrous backs whereas in other populations all of the plants may have the bracts rather densely pubescent with long hairs. Many types of intermediate conditions occur and some populations show both the glabrous and the densely pubescent forms. A large proportion of the plants from Colorado show densely pubescent bracts whereas the eastern Texas "races" and the cultivated sunflowers generally have the bracts sparingly pubescent.

Leaf shape in plants grown in the experimental garden appears to be rather uniform, with the exception of the so-called abnormal populations, although it varies considerably in nature. The variation in nature is probably due to environmental modification. There is some variation in intensity of color of the leaves. Stem color also varies from greenish to reddish or strongly mottled. The strongly mottled types seem to occur with greater frequency in Texas. Ray color varies from a pale yellow to a deep orange yellow. The lighter color thus far is known only from Texas with the exception of a very pale primrose-rayed form seen in one population (5128) from Indiana which may represent a recent mutation.

DEVIATIONS FROM THE GENERAL PATTERN

Certain generalizations concerning the variation pattern have been made in the foregoing sections. However, it was noted that there were many exceptions. In regard to their measurements certain populations of the west appear to fall within the eastern class. It may be that these populations are recent emigrants from the east or that they owe their origin to hybridization between typical western forms and cultivated plants with large disks and many rays. These populations are indicated by the large dots in figs. 2 and 3.

Seeds for the Washington "race" (D29) were secured from Dr. Marion Ownbey and in a letter accompanying the seeds he states that he suspects that the plants in this locality, as well as elsewhere in the northwest, owe their origin to hybridization between wild and cultivated sunflowers. Such hybridization could readily account for the large disks of this population as well as for the great variability in both the ray number and disk diameter. A second Washington population (5101) also appears to owe its origin to such hybridization. This population was characterized not only by large disks and numerous rays but all four types of anther color as well. The presence of black anther color in this region is very suggestive of hybridization with the cultivated sunflower.

The high ray number, large disk diameter, and the extreme variability of the California population (D42) is readily explained since the history of the parent seed sample is well known. A naturally occurring population of plants growing near the roadside between Davis and Sacramento (1856, Heiser, 1949) was interpreted as a hybrid swarm of the native California *H. annuus* and the cultivated sunflower, and seeds were collected from a putative F_1 plant. The extreme segregation in the progeny, which accounts for the high V value in table 1, and the fact that one segregate had black anthers strengthen the assumption that this plant was actually of such hybrid origin. It is of interest to note that the means of this population are almost identical to those of the Nebraska population (4945). Hence there is strong evidence that the plants appearing in the west similar in size to those from the east represent derivatives from hybridization between the wild and cultivated sunflowers. This same explanation probably holds for the other abnormal California population (D46). The parent plants, which were collected by the writer, were interpreted as F_2 derivatives, or backcrosses of a wild \times cultivated hybrid to the cultivated parent. These four populations have been selected for special comment but it seems likely that such hybridization may have influenced considerably the plants in other parts of the west also.

The seeds for population 5038 from Minnesota were collected by Mr. Floyd Carter and the exact nature of the parent plants is not known. The measurements in table 1 agree closely with those of artificial hybrids between cultivated sunflowers and the eastern forms. The presence in this population of 11 plants with black anthers also suggests that such hybridization may have occurred. The measurements of the plants from North Carolina (5044) also suggest a hybrid origin although the variability in these plants is not particularly marked. Such low variability would be expected if all the plants were F_1 's, however. The population from Indiana (5129) also probably falls into this category. Thus it is seen that hybridization with the cultivated sunflower in the east may influence the variation pattern in this area.

The question may arise as to whether all of the eastern plants are actually hybrid swarms between the western type of sunflower and the cultivated forms. Populations of sunflowers in St. Louis and Indianapolis have been under observation for several years and although considerable variation is present they appear to represent fairly stable entities rather than hybrid swarms. This, of course, does not negate the hypothesis that they may have originally been of hybrid origin.

Not all of the exceptional populations are so readily interpreted as the ones discussed above, but comments concerning some of them seem to be in order.

Population D45 from Illinois showed unusually small disks and few rays for an eastern population. The original seed for these plants came from a railroad yard in East St. Louis near the location of a hybrid swarm of *H. annuus* and *H. petiolaris*. It seems possible that the low ray number and the small disks of D45 may be the result of introgression from *H. petiolaris* or that this population might represent recent emigrants from the west by way of the railroads.

The one Texas population (5016) with an unusually high ray number and large disks came from the campus of the Texas A. & M. College. Although no cultivated plants were seen in this vicinity, a possible explanation

for the large size of the plants, of course, could be that the cultivated sunflower had been grown here in the past and hybridized with wild sunflowers.

CYTOGENETICS

The haploid chromosome number of *H. annuus* has previously been reported as 17 by a number of workers. This number has been verified in the present study for two cultivated races and for wild plants from California, Arizona, Colorado, Texas, and Missouri.

Reciprocal crosses have been made between the following "races": Cultivated variety (Mammoth Russian) x Imperial Co., Cal. Cultivated variety (Mammoth Russian) x St. Louis, Mo. St. Louis, Mo. x Zavala Co, Texas. St. Louis, Mo. x Coconino Co., Ariz. St. Louis, Mo. x Kings Co, Cal. St. Louis, Mo. x Imperial Co, Cal. Yo'lo Co., Cal. x Los Angeles Co, Cal.

The pollinations gave normal seed set in all crosses attempted. The F_1 generation has been grown for all of these crosses, and the plants secured were all vigorous and fully fertile. Small F_2 generations for the first three crosses listed have been grown and these also produced vigorous, fully fertile plants which showed segregation of the characters of the two parental types.

Although detailed genetic studies have not been attempted, certain observations are of interest here. Branching and purple disk, as previously shown by Shull (1903), are dominant to non-branching and yellow disk. The disk color is apparently controlled by a single gene, as originally suggested by Shull, but the number of different branching patterns occurring in the F_2 indicate that the gene controlling branching is conditioned by modifiers. Black anther color apparently is linked to or controlled by the same gene as yellow disk and is recessive to purple anther color.

From the evidence presented in this section it is clear that we are dealing with a single species and that hybridization can take place readily between races to give rise to fully fertile hybrid derivatives such as are suspected to occur in nature.

CONCLUSIONS

Taxonomy.—It has now been shown that there is considerable variation in the common sunflower, and moreover, the variation of certain characters, with some deviations, is geographic. However, no sharp discontinuities exist in the variation pattern. The question that now presents itself is how to treat this situation taxonomically. Should formal taxonomic recognition be given to any of the variant populations within this species? Certainly for convenience, chiefly to facilitate discussion, a positive answer is called for. Varietal names are already available for the principal races, or collections of races, and these have previously been employed (Heiser, 1951c). It is proposed here that this system be abandoned and that the category of subspecies be used for the naturally occurring races. Although the subspecies to be delimited here are certainly not equivalent to the subspecies in many other groups which have not been so closely associated with man, they do form a "more or less distinct regional facies" of the species (Du Rietz, 1930). Three such subspecies are recognized below and in addition the cultivated sunflower is accorded varietal rank. It is apparent that these various subspecies and the variety are composed of numerous "sub-races" and "forms," but to attempt to name all of them at present would accomplish little or nothing in helping

to understand the pattern of evolution within the species. It is now apparent, I think, that many if not most species comprise numerous minor variants.

1. *HELIANTHUS ANNUUS* ssp. *LENTICULARIS* (Dougl.) Ckll.*

Plants generally 0.5 to 2.5 M tall, branched; lower leaves lanceolate to ovate, truncate to cordate at base; involucre bracts 4.0-7.0 mm. broad, sparingly to densely pubescent; disk generally 2.0 to 3.5 cm. in diam.; rays 17 to 26, 2.5-3.9 cm. long, 0.9-1.3 cm. wide; disk flowers generally red or purple, anthers reddish or purplish, rarely yellow; achenes 4.0 to 5.5 mm. long:

Distribution: Western North America from southern Canada to northern Mexico.

The description is drawn from the plants grown in the experimental garden (excluding those obviously the result of recent crossing with the cultivated sunflower) supplemented with the study of plants in the field in Arizona and California and specimens from a number of herbaria. A few specimens have been seen which have much smaller measurements than those given above. In all probability such plants are environmental modifications although this remains to be tested by experiment. The lanceolate-truncate leaf form also is apparently due to such modification for the plants of this subspecies cultivated in the experimental garden had ovate leaves (with the exception of the so-called abnormal forms—see above) which were at least somewhat cordate at the base.

A comparison of the descriptions reveals that this subspecies grades into the more eastern subspecies so that plants from the Dakotas, Colorado, Kansas, Nebraska, and Oklahoma are frequently somewhat intermediate and are not always positively placed in one subspecies or the other. This may be a source of confusion to those taxonomists who would like to have a precise name for every plant, but it does not necessarily invalidate the subspecific concept adopted here, for intergradation of subspecies at the zone of contact is to be expected. The zone of intergradation here is an unusually large one and probably results from the weedy nature of these plants.

This subspecies appears to be very successful judging from its wide overall distribution and its occurrence in altitudes from sea level to 8,000 feet. Considerable variation exists within the subspecies and it may eventually be desirable to recognize more than one race. When more material is available, it may prove that the plants of the far west with the smaller heads, fewer rays, red anthers, and generally sparingly pubescent involucre bracts are fairly distinct from the plants of the Rocky Mountains with their larger heads, more numerous rays, purple anthers, and generally rather densely pubescent involucre bracts.

2. *Helianthus annuus* ssp. *texasus* ssp. nov.**

Plants 1.5 to 2.5 M tall, usually much branched, stem frequently conspicuously purple and green mottled; lower leaves ovate, cordate at base, occasionally somewhat jag-

* Science 40:284. 1914. *H. lenticularis* Dougl. Bot. Reg. t. 1265. 1829. *H. annuus lenticularis* Ckll. Bot. Gaz. 45:338. 1908. *H. annuus* (a) *lenticularis* Ckll. Am. Nat. 49:611. 1915.

** *Plantae speciei habitu congruentes sed ramosissime, caulibus maculatis; foliis inferioribus per occasionem profunde et irregulariter serratis; bracteis involucri 4.0-6.0 mm. latis, sparse pubescentibus; discis plerumque 2.1-3.0 cm. diametro; ligulis dilute flavis 19-25, 2.4-3.2 cm. longis, 0.8-1.2 cm. latis; floribus disci et antheris purpureis; acheniis 3.3-5.0 mm. longis.*

Exemplum typicum: Banks of Frio River west of Knippa, Uvalde Co., Texas, July 17, 1949 Heiser 3062 (Indiana University, TYPE).

gedly serrate; involucre bracts 4.0 to 6.0 mm. broad, generally sparingly pubescent; disk generally 2.1 to 3.0 cm. in diameter; rays light yellow, 19-25, 2.4 to 3.2 cm. long, 0.8 to 1.2 cm. wide; disk flowers and anthers purplish; achenes 3.3 to 5.0 mm. long.

Distribution: Eastern Texas.

This race has already been discussed in some detail elsewhere (Heiser, 1951a). In the discussion in the preceding pages all of the Texas plants have been lumped together for convenience. However, in all probability two of the samples (5011, 5012 in table 1) are nearer morphologically to *H. annuus* var. *lenticularis*, and another race (5016) shows several atypical features (see above). As would be expected this subspecies grades into *H. annuus lenticularis* in western Texas and in northern Texas it grades into *H. annuus annuus*. However, in the typical form of these other subspecies the rays are generally a deeper yellow, the mottling of the stem is less pronounced, and the serration of the leaves is rarely somewhat jagged. Although the disk diameters and ray numbers of subspecies *texanus* broadly overlap those of the previous subspecies, the combination of characters such as the mottled stems, light yellow rays, purple anthers, and the short narrow achenes rather effectively distinguish this group of plants from the more western populations.

3. *HELIANTHUS ANNUUS* ssp. *ANNUUS* L. Sp. Pl. 906. 1753*

Plants 1.7 to 3.4 M tall, branched; leaves ovate, cordate at base; involucre bracts 7.0 to 10.0 mm. broad, sparingly to densely pubescent; disk 3.0 to 5.0 cm. in diameter; rays 21-35, 3.0 to 5.0 cm. long, 1.0 to 1.5 cm. wide; disk flowers red, purple or yellow; anthers purple or black; achenes 4.0 to 7.0 mm. long.

Distribution: Central and eastern United States extending into south central and eastern Canada.

This subspecies which previously has often been referred to as the "ruderal" or "weed" sunflower is common in the middle western United States particularly in railroad yards and vacant lots around towns. Its distribution is exceedingly sporadic east of the Mississippi. In all probability the sunflower is very recent in this area. It is a heliophilic species and certainly could not spread into the original forest cover of the east. Intolerance to high relative humidities may be one of the limiting factors to its successful invasion of the southeastern United States.

Plants agreeing with the description of this subspecies are occasionally met with in the western United States and in all probability such plants owe their origin to hybridization between *H. annuus lenticularis* and the cultivated sunflower (see above).

The majority of the forms or horticultural varieties of *H. annuus* cultivated as ornamentals should also be referred to this subspecies.

4. *HELIANTHUS ANNUUS* var. *MACROCARPUS* (DC.) Kell.**

Plants 1.2 to 4.0 M tall, unbranched or rarely with short branches above; leaves very large, ovate, cordate at base; involucre bracts over 8.5 mm. broad, generally sparingly pubescent; disk over 5.5 cm. in diameter; rays 30-70, 3.5-10.0 cm. long, 1.5 to 3.0 cm. wide; disk flowers red, purple, or yellow; anthers purple or black; achenes 6.5 to 15.0 mm. long.

* For a discussion of the type specimen of this species see Heiser, 1949.

** Science 40:709. 1914. *H. macrocarpus* DC. Pl. Rar. Jard. Gen. Vme. Not. 8. 1826. (Various names for this sunflower have been published in the Soviet Union in recent years but without regard for the rules of nomenclature; hence these are being ignored.)

This is the sunflower which is cultivated for its oily seed and which has been referred to as the cultivated sunflower throughout the body of the paper. Although it is not an important cultivated plant in the United States, it is extensively grown in gardens throughout the country. In nature this variety is unable to maintain itself any length of time, although its genes spread frequently to the wild plants by means of hybridization. Many horticultural forms or varieties are known, based chiefly upon the pigmentation of the achene and to a lesser extent upon the height of the plants. Since this plant occurs only in cultivation, I have chosen to employ the category of variety for it rather than that of subspecies.*

THE ORIGIN OF THE SUBSPECIES

In his discussion of the classification of human races Kroeber (1948:156) points out that "the unscrambling of a composite race into its original pure-race constituents is a process that is far from simple and far from sure. No matter how quantitatively the constituents are defined, and how statistically validated the final analysis is, a subjective factor enters the process. Consequently the findings are speculative as the population is complex in its origins." The classification and the tracing of the origins of cultivated plants is equally complex. In *H. annuus*, for example, the origins of the subspecies involve not only intraspecific hybridization, but interspecific hybridization as well. It may well be that there were no original "pure-race constituents." Although with the present state of our knowledge, it might seem premature to discuss the origin of *H. annuus* and its subspecies; some speculation on the subject appears to be worth while.

Relationships of Helianthus annuus.—All of the annual species of the genus *Helianthus* appear closely related, and we cannot point to any one species as a direct progenitor of *H. annuus*. Both morphologically and genetically *H. annuus* appears to be most closely related to *H. argophyllus* of southern coastal Texas, which differs from it chiefly by a dense pubescence and restriction to sandy soils (Heiser, 1951b). It seems likely that these two species come from a recent precursor or it is even possible that *H. annuus* gave rise to *H. argophyllus* rather than the reverse. Hybridization between these two species in nature occurs to a limited extent, and *H. annuus* is also known to hybridize with *H. petiolaris*, *H. Bolanderi*, and *H. debilis* var. *cucumerifolius* (Heiser, 1947; 1949; 1951a). However, on morphological grounds it appears unlikely that any of these species as we know them today could have given rise to *H. annuus*. The distribution of *H. petiolaris* partly coincides with that of *H. annuus* but again the former species is nearly always confined to sandy soils. Two other annual sunflowers, *H. praetermissus*, known only from one locality each in Texas and New Mexico (Heiser, 1948; Shinnars, 1950) and *H. Jaegeri*, known from a few localities in southern California and Nevada (Heiser, 1948 and unpubl., Munz and Roos, 1950), have many morphological features similar to those of *H. annuus*, and these species are as yet so little known that further speculation is unprofitable. It is, of

* Taxonomic purists may object to the use of a variety name here without any sub-specific designation. For such people the names *H. annuus* ssp. *annuus* var. *annuus* and *H. annuus* ssp. *annuus* var. *macrocarpus* could be employed, although such tetranomials are exceedingly cumbersome and also tend to reflect a precision of knowledge of relationships that cannot be attained as yet.

course, possible that *H. annuus* might have descended directly from some perennial species, but on the basis of our present knowledge of the genus this seems unlikely. With no fossil evidence at hand it seems best to conclude at present that *H. annuus* comes from a now extinct annual species or from an annual species that has been highly modified since giving rise to *H. annuus*.

HELIANTHUS ANNUUS ssp. LENTICULARIS

There are four possible origins of *lenticularis* that are worth listing. (1) This subspecies is essentially similar to the original form of the species, although it has been considerably modified by hybridization within the species and with other species. (2) This subspecies represents a western migrant descended from *texanus*. (3) This subspecies has resulted from the crossing of other species with *annuus*, the offspring of which have become more or less stabilized in the west. It is known that crosses between subspecies *annuus* and *H. petiolaris* give segregates in the second and third backcross generations which approach *lenticularis* in appearance (Heiser, unpubl.). (4) The possibility also exists, as pointed out by Ames (1939), that the so-called progenitors of cultivated plants may simply be feral forms, which arose as escapes from the domesticated plant whose origin is no longer traceable. The occurrence of *lenticularis* chiefly, if not entirely, in man-made habitats might suggest that it is simply an escaped form of *macrocarpus* which has reverted to a semi-wild existence.

Although there is no justification for identifying some one contemporary race of *H. annuus* with the original form of the species (Benedict, 1948:17) it seems reasonable to consider *H. annuus lenticularis* as the nearest to the original form. It has the small size characteristic of closely related species and it comes closer to being a wild plant in that it grows in less disturbed areas than *H. annuus annuus*. However, *lenticularis* may have been so modified by hybridization with other species that it is difficult to visualize what the "pure" species may have been like and it seems equally difficult to postulate a center of origin at present.

HELIANTHUS ANNUUS ssp. TEXANUS

In general the problems involved in tracing the origin of this subspecies are the same as those confronted in tracing the origin of the preceding. It is possible that it is similar to the original form of the species or that it differentiated more or less at the same time as did *lenticularis*. However, far more likely in view of the previous work on the Texas sunflowers (Heiser, 1951a) is the possibility that this race arose from the introduction of either *lenticularis* or *annuus* into Texas and the subsequent "contamination" from hybridization with *H. debilis* var. *cucumerifolius*.

HELIANTHUS ANNUUS ssp. ANNUUS

In view of the foregoing discussion it seems likely that subspecies *annuus* was neither the original form nor that it descended from *texanus*. The most likely hypothesis then is that this subspecies arose from *lenticularis*. The achenes of the latter were gathered for food by various tribes of Indians (Heiser, 1951c), and the sunflower may have become an early Indian camp following weed adapted to disturbed areas around village sites. In time,

either through conscious or unconscious selection by man, *lenticularis* could have given rise to the slightly larger forms which developed into *annuus*. Such evolution could have occurred more readily in the middle west or east where gene flow between the newly evolving subspecies and the more westward *lenticularis* would have been reduced or eliminated. Such isolation would have favored the "fixing" of this subspecies originally, although the barriers between the two subspecies have since broken down.

As has been pointed out above, however, crosses between *lenticularis* and *macrocarpus* give F_1 plants which are nearly identical to *annuus* in appearance. It is conceivable then that *annuus* did not arise directly from *lenticularis* but rather as the result of hybridization of this variety with the cultivated sunflower. The *annuus*-like plants in the west today almost certainly owe their origin to such a process, but whether the subspecies as a whole is the result of such hybridization is doubtful, for in the central and eastern United States *annuus* appears to be a more or less stable and self-perpetuating entity and not merely a hybrid swarm. Moreover, if one assumes that *annuus* is of such hybrid origin, it means that the cultivated sunflower must have arisen directly from *lenticularis*.

HELIANTHUS ANNUUS var. MACROCARPUS

If the first of the above two hypotheses is accepted for the origin of *annuus*, it would seem highly probable that this subspecies in turn gave rise to *macrocarpus*. A single mutation restricting branching could account for the principal difference between the two. Selection for this new recessive mutation and a small number of subsequent mutations could have given rise to the new variety in a relatively short time. If this hypothesis is correct, it means that the cultivated sunflower must have originated somewhere in the central or eastern area.

The other possibilities that *macrocarpus* comes directly from *lenticularis*, *texasana*, or that it was similar to the original form of the species seem rather unlikely.

Significance.—The variation pattern in *H. annuus* is quite different from that seen in many wild species in which subspecies with a well-defined range and a minimum of intergradation may be recognized. Even in *Asclepias tuberosa* (Woodson, 1947), a species with weedy tendencies, the subspecies are far more clear cut than in *H. annuus*. In *H. debilis*, an annual sunflower closely related to *H. annuus*, the subspecies are more or less geographically isolated and form fairly distinct taxons (Heiser, unpubl.). The explanation of this difference apparently lies in the fact that for the past several hundred or even thousands of years *H. annuus* has been carried back and forth across the country both as a weed and as a cultivated plant, and as a result there has been extensive hybridization within the species and with other species.

This phenomenon of the natural crossing of a weed and a cultivated plant is of particular interest and is by no means limited to *Helianthus*. For example, such hybridization is known in lettuce between *Lactuca sativa* and *L. serriola*, between weedy and wild forms in *Brassica*, in *Citrullis vulgaris* between the watermelon and the citron, between *Zea mays* and *Zea (Euchlaena) mexicana*. In many of the plants in which such hybridization occurs, escaped forms of the cultivated plants are probably involved as the weed parents, although in others truly wild species may be involved. Little is known, how-

ever, about how greatly such crossing has affected the variation in the wild plant throughout its range and our knowledge of the situation in the sunflower is still fragmentary. How greatly the hybridization has affected the cultivated parent also has been little studied. Probably in most cases, and particularly in recent times, there has been strong selection by man against the genes introduced from the weedy form, but new types of plants important to man have probably been produced through spontaneous hybridization. Schieman (1951), for example, has postulated the origin of the two-rowed cultivated barleys from hybridization between the six-rowed cultivated barleys and the wild *Hordeum spontaneum*.

As Stebbins (1947) has pointed out, man is proving to be an important factor in the evolution of plants today. That man may eventually completely destroy the remnants of the original pattern of variation in many plants seems a distinct possibility. It is remarkable that, in spite of the many complicating factors tending to alter the original trend of variation in *H. annuus*, any pattern at all can be detected. An answer to this apparently anomalous condition is provided by Natural Selection—plants of a species introduced into an area rarely compete successfully with the plants of the species already adapted to that area, and in spite of hybridization those populations which have long been adapted to an area are not readily changed.

In spite of the complex type of variation seen in this species certain generalizations can be drawn. It is possible to recognize four rather well-marked though intergrading taxons and to speculate on their origins. It is likely that subspecies *lenticularis* of western North America is more like the original form of the species than any other living race. This subspecies in turn probably gave rise to the more eastern subspecies *annuus* which in turn, under selection by man, gave rise to the cultivated sunflower, variety *macrocarpus*. The Texas sunflower, on the other hand, probably owes its origin to hybridization of either *lenticularis* or *annuus* with another species, *H. debilis* var. *cucumerifolius*.

The above hypothesis for the origin of a cultivated sunflower is not a unique one. A similar hypothesis is used by Sinskaja to explain the origin of cultivated hemp (see Vavilov, 1926). Sinskaja pictures the following steps in the evolution of hemp: the plant in the wild condition; the plant spreading from wild centers to populated places; utilization of the weed form by the human population; and the actual cultivation and rise of the cultivated plant.

SUMMARY

Helianthus annuus is a widely distributed and highly variable species comprising both cultivated and wild or weedy forms. Primarily through the culture of plants from many different areas in the experimental garden, variation of certain characters has been studied. Purple anther color is found throughout the entire range of the species; red anther color is seen in plants from the west; black anther color is found in the cultivated sunflower and occasionally in plants in nature from the central and eastern United States. Great variation is found to exist in ray number and disk diameter. Plants with small disks and few rays occur in the west and Texas whereas the more eastwardly plants have more numerous rays and larger disks. The plants from Texas are found to have the smallest achenes and the achene length is

quite variable in the west and east, although there is a tendency for the eastern plants to have larger achenes. Certain exceptional western populations have been grown which have large heads and achenes, numerous rays, and occasionally black anthers and it is suggested that they have arisen through hybridization of the native sunflowers of the region with the cultivated sunflower. There is also some evidence of hybridization of the cultivated sunflowers with the wild "races" in the east. All "races" of the sunflower thus far known are homoploid and the hybrids between races are vigorous and fertile. Three subspecies, *lenticularis*, *texanus*, and *annuus*, and one variety, *macrocarpus*, are recognized and described. Some speculation is entertained in regard to the relationships of *H. annuus* and the origin of its subspecies. Subspecies *lenticularis* is probably the most similar to the original form of the species, subspecies *annuus* arose from *lenticularis*, and in turn gave rise to variety *macrocarpus*. Subspecies *texanus* is thought to have arisen as the result of the introduction of either *lenticularis* or *annuus* into Texas with the subsequent introgression of genes from *H. debilis* var. *cucumerifolius*. It is probable that the complicated variation pattern exhibited by *H. annuus* can be explained largely by the weedy nature of the species and the extensive hybridization within the species and with the other annual sunflowers.

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A Report on the Mature Wood of the Syrian or Drupe-Fruited Juniper, *Juniperus drupacea* Labill.*

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Because no record of the anatomy of the mature wood of the Syrian juniper, *Juniperus drupacea* Labill. (also known as *Arceuthos drupacea* (Labill.) Ant. and Kosch.) has been available, many requests to various forestry stations and to individuals were made during the last year and a half. The results of this study are based upon wood specimens obtained from two forestry stations in Turkey and one from the Institute of Forestry Research of Athens, Greece. The writer has deposited certain specimens from these collections with the Chicago Natural History Museum, I. W. Bailey of Harvard University, Yale University School of Forestry, Archie F. Wilson of the Wood Collectors Society, and the U. S. Forest Products Laboratory at Madison. Phillips (1941) has described the wood of twig specimens, and the writer has also examined twig specimens from six different sources.

According to Dallimore and Jackson (1948), the plant is a native of the mountains of Asia Minor, Syria and Greece. It is found at elevations of 1,600-5,600 feet, either forming pure stands or mixed with other conifers.

One 85 year old cross-cut (diameter 11.5 cm.) and one 50 year old cross-cut (diameter 6 cm.), together with twigs and female cones, were supplied by the Regional Forestry office of Adana, Turkey. This material carried the following information: From Sahmurlu Alanbasl (Silifke); north slope; 21 km. distance from sea level; 1140 m. above sea level; height of cross cuts, one meter from ground. A second shipment from the Regional Forestry office of Antalya, Turkey included one 80 year old cross-cut (diameter 14 cm.) together with twigs and one female cone. This material carried the notation that it came from the forest of "Gazi pasha" (town of Antalya) where the trees are found "one by one" in the forest. The cross-cut was made 30 cm. from the ground from a plant growing 850 m. above sea level.

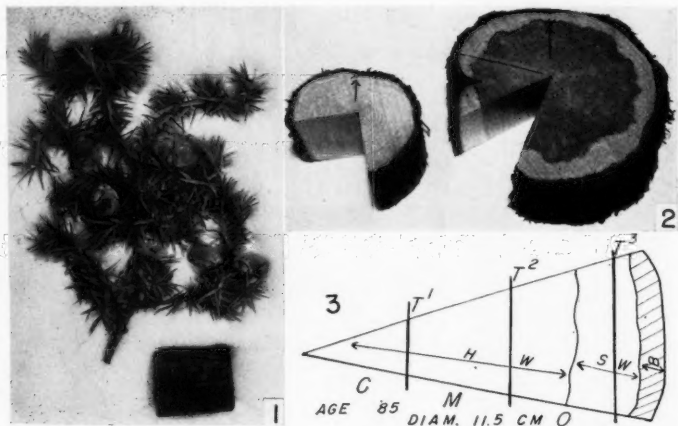
A cross-cut, approximately 55 years of age (diameter 15 cm.), was provided by Panos Grekiotis of the Institute of Forest Research, Athens, Greece. The specimen was taken from the forest of Stalamata on Mt. Parnon in Peloponnese, located between Sparta and Argolikos Gulf. It was taken from a tree about 28 feet in height, cut 3½ feet above ground level. The species grows within a zone of average elevation of 2,000 feet. Dr. Grekiotis reports that from a plant geographic point of view it belongs to the "Etagé Méditerranéenne de haute montagne." It is found growing on calcareous soil composed of a red-brown type of earth ("terre jaune méditerranéenne") but not of "terra rossa." It is a pioneer species to the Grecian fir, *Abies cephalonica* Loud., growing in forest stands as well as an isolated tree, and reaching a height of 30 feet and a diameter of one foot.

Twig specimens were obtained from the following sources: 1) U. S. National Herbarium (*Plantae montium Syriae borealis*; Ex Herb. Postian. apud Colleg. Syriens. Protest., 1884); 2) Forestry Station of Adana, Turkey;

*Aided in part through University Research Grant

3) Forestry Station, Antalya, Turkey; 4) one 18 year old specimen from the Arboretum at Oldenzaal, Holland, sent by C. M. Gelderman; 5) one 40 year old specimen from the Pinetum "Blijdenstein," Hilversum, Holland, sent by G. Bootsman; 6) one tree growing in the Huntington Botanical Garden, San Marino, California, sent by R. B. Townsend.

There is diverse opinion concerning the taxonomic status of the species. According to Pilger (1926) this form is called *Arceuthos drupacea* (Labill.) Ant. and Kosch., the species being the only one of the genus. On the other hand, many workers (Rehder, 1940 *et al.*) accept the older treatment of Endlicher (1847) and place the one species within Section I, *Caryocedrus* of the Genus *Juniperus* where it is called *J. drupacea* Labill. Although Bucholz (1946, 1948) lists *Arceuthos* with *Juniperus* in his *Classification of the Coniferales* he considered *Arceuthos* "a questionable juniperoid genus, confined to Macedonia and possibly Asia Minor" (1948). The combination with *Arceuthos* appeared in 1854 by Antoine and Koschy. The even older argument of *Juniperus* vs. *Sabina* would include this species with those in Section II *Oxycedrus* (of Endlicher) in the *Juniperus* grouping. The *Sabina* grouping would correspond to Endlicher's Section III *Sabina*. It is not the purpose here to settle the question of the proper scientific name of this species but rather to point out that *J. drupacea* Labill. clearly identifies the species and has been the name used in correspondence received from England, various regions of Europe, the Eastern Mediterranean, as well as in the United States.

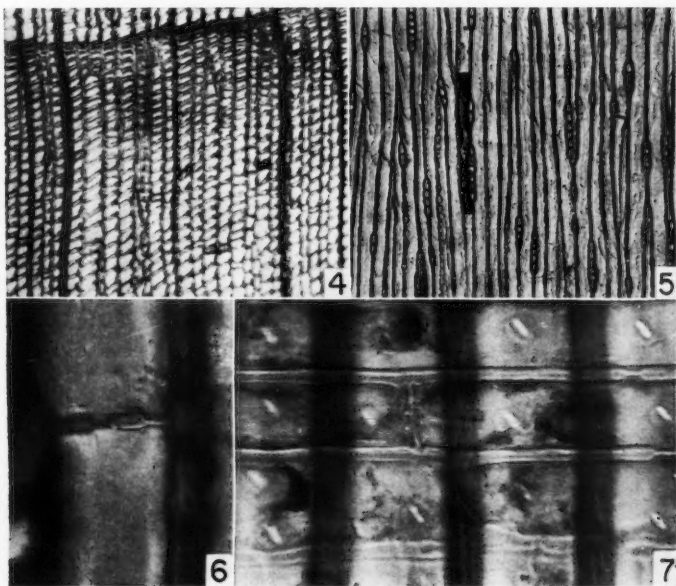


Figs. 1-3.—1. Twig of *Juniperus drupacea* bearing female cones, together with view of bark from 50 year old cross-cut. 2. View of cross cuts of wood specimens. Specimen to left 50 years old; heartwood not colored. Specimen to right 85 years old, showing irregular outline of colored heartwood. Both specimens show regions of "compression" wood in regions marked "N." 3. Diagram to show regions from which precise transverse, tangential, and radial sections of wood were obtained from various cross-cut samples. C, center section; M, middle section; O, outer section; T-1, plane from which tangential sections were cut of C section; T-2, same for M section; T-3, same for O section. HW, heartwood; SW, sapwood; B, bark.

The twig wood material agrees, in general, with that reported by Phillips (1941) and with most of the microstructural features of the mature wood reported here.

Figure 1 shows twig with female cones and a portion of the bark from the 50 year old cross-cut supplied by the Regional Forest Office of Adana, Turkey. The large stiff leaves in whorls of 3 and adherent at their bases are easily recognized features. This species possesses the largest female cone of the "jun per group." It is partly woody and cupressoid-like, maturing the second year and reaching a diameter of 2.5 cm.

Figure 2 shows both the 50 and the 85 year old cross-cuts. The older specimen (right) disclosed reddish-brown heartwood (as did the other older collections), although the younger cross-cut (left) shown here had none. From this illustration it can also be seen that on the north sides of the cross-cuts (labelled "N") definite effects of "north slope" are reflected by the presence of compression or reaction wood (Sinnott, 1952). General features of the wood also include: sapwood pale yellow; growth rings distinct with late (summer) wood zone darker and much narrower than early (spring) wood; growth rings sinuate and frequently eccentric; mild "cedar-like" odor and taste; not greasy; straight, even-grained and fine-textured. Wood moderately hard



Figs. 4-7.—4. Transverse section of wood of 85 year old specimen from Adana, Turkey. Darker scattered cells are xylem parenchyma. Note uniseriate rays. This specimen lacks intercellular spaces between tracheids. 5. Tangential section of wood to show low rays. Dark-stained cell is wood parenchyma with nodular transverse walls. 6. Nodular cross wall of xylem parenchyma. Tangential section. 7. Radial view of ray parenchyma to show indentures, nodular end-walls, thick horizontal walls with primary pit-fields. Cupressoid cross-field pits.

and heavy for conifers. Xylem parenchyma abundant for conifers, often darker than background. Rays very fine, darker than background, forming low fleck in radial section. No resin canals.

Figure 3 shows, diagrammatically, how a sector of wood of the 85 year old specimen was cut for tangential, radial, and cross sectional studies to check for any differences in size of cross-field pits from early (spring) wood and for other variations in microstructural features that might be influenced by the age of the wood. Sectors from the other cross-cuts were prepared for study in a similar fashion. No significant differences were noted in the wood samples after approximately the tenth year in any of the samples.

Precise transverse, tangential and radial sections of the various wood samples were cut with a sliding microtome between 20 and 30 microns. These were stained in the usual manner with safranin and fast green before being mounted in balsam.

Figure 4 shows the wood of the same specimen in transverse section. Cells with dark-stained contents are the xylem parenchyma. An unusual feature of the wood is the absence of conspicuous intercellular spaces between tracheids. Both specimens from Adana lacked these spaces (except for occasional quite small ones), although they were found in the other specimens. It may be recalled that tracheids of variable shape in cross section are found among species of *Juniperus*. It is interesting to note that the specimens growing at the highest elevation lacked the intercellular spaces.

TABLE I.—Microstructural features of mature wood

TRACHEIDS

1. Radial pits 1-rowed not touching throughout greater length
2. Tangential pits common in terminal wood

CROSS-FIELD PITS (EARLY WOOD)

1. Cupressoid
2. 1-4, opposite
3. Aperture length markedly uniform, approximately 6 microns

XYLEM PARENCHYMA

1. Present
2. Solitary, usually
3. "Resinous"
4. Abundant for conifers
5. Metatracheal to diffuse
6. End-walls nodular, nodules approximately 3 microns
7. Vertical primary pit-fields present but inconspicuous because of thin walls (1.5-2 microns)

RAYs

1. Uniseriate
2. Ray parenchyma only
3. "Resinous"
4. Horizontal walls relatively thick, i.e. as thick as walls of contiguous tracheids (3 microns) in radial aspect
5. Horizontal walls with primary pit-fields
6. Indentures present
7. End-walls finely nodular, nodules often less than 3 microns
8. Average height of ray cells 18 microns
9. Range in number of cells in rays (height) 1-16 (low for conifers)
10. Most frequent range in numbers of cells in rays 2

Figure 5 shows the wood of the same specimen in tangential section. Low rays (characteristic of *Juniperus*) are discernible. The dark-stained cell is one of the xylem parenchyma cells whose transverse walls are nodular (better observed enlarged in fig. 6). Figure 7 is a radial view of portions of ray parenchyma cells showing indentures in end-walls and end-walls nodular; horizontal walls are relatively thick and with primary pit-fields. Cupressoid cross-field pits are visible in the background.

Table I summarizes the outstanding microstructural features of the mature wood. These characteristics agree with most of those reported for species of *Juniperus* by Peirce (1937) and Phillips (1941) except that no ray tracheids were found. Peirce indicates that these occur sporadically within the genus. Ray tracheids are not considered a significant characteristic of the group. The relatively thick (thicker than in other genera of the Cupressaceae) horizontal walls of the ray parenchyma cells with many depressed primary pit-fields are considered typical for the genus. This species shows both characteristics. Relative thickness of ray parenchyma walls was considered also in relation to contiguous tracheid wall thickness in radial sections. Here, again, the classification of the wall would be that of "thick."

From the microstructural study of the mature wood it is concluded that this species is more similar to *Juniperus* than to any other genus of the Cupressaceae. This conclusion is based upon the combination of the following characteristics: 1) Ray parenchyma with a) horizontal walls relatively thick; b) abundant primary pit-fields in horizontal walls; c) indentures regularly present; d) end-walls nodular; and 2) Wood parenchyma with nodular transverse walls.

The writer wishes to thank the various forestry stations and individual donors for collections of this species. Sincere thanks, also, are due Dr. B. Francis Kukachka, U. S. Forest Products Laboratory, Madison, for his interest and encouragement.

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Notes and Discussion

Additional Records of Amphibians and Reptiles in Southern Illinois

The amphibians and reptiles reported in this paper are contributions to additional knowledge of the fauna of Southern Illinois. Some of these species herein recorded are apparently rare while others are more common (Cagle, 1942. Amer. Midl. Nat. 28:164-200). The common forms found have not been included in this paper.

These collections have been made from Alexander, Union, Jackson, Pope, Pulaski, Hardin, Gallatin and Saline Counties. No attempt has been made to give environmental and habitat conditions.

All specimens of the species reported are in the collection of the author in the zoology department of Southern Illinois University at Carbondale, Illinois.

The nomenclature used was that of Smith (1946. Handbook of lizards. Comstock Publ. Co., Ithaca, N. Y.), for lizards, Bishop (1943. Handbook of salamanders, Vol. III. Comstock Publ. Co., Ithaca, N. Y.), for salamanders, Blanchard (1944. A key to the snakes of the U. S., Canada and Lower California. U. Mich. Press, Ann Arbor), for snakes, and Carr (1952. Handbook of turtles. Comstock Publ. Co., Ithaca, N. Y.) for turtles.

SALAMANDERS

Triturus viridescens viridescens Rafinesque: Boskey Dell, September 1949; Union County State Forest, September 15, 1951; Pine Hills, March 30, 1952; Pine Hills, July 20, 1952.

Ambystoma talpoideum (Holbrook): A previous report by the author (Stein, 1934. Trans. Ill. Acad. Science. 26(3)135) established a new northern limit for this form. It was found again at Horseshoe Lake Island, March 29, 1952.

Ambystoma tigrinum tigrinum (Green): Carbondale, March 1950; La Rue, 1951; Carrier Mills, October 15, 1951.

Ambystoma maculatum (Shaw): Wolf Lake, May 1950; Horseshoe Lake Island, March 29, 1952.

Ambystoma opacum (Gravenhorst): Union County State Forest, September 15, 1951; Carbondale, September 18, 1951; Horseshoe Lake Island, March 29, 1952.

Ambystoma texanum (Matthes): Union County State Forest, September 1951; Carbondale, September 18, 1951; Horseshoe Lake Island, March 29, 1952; Sandusky, April 2, 1952.

Desmognathus fuscus fuscus (Rafinesque): one mile north of Olmstead, Illinois, collected by John Oberheu, October 21, 1951 and again March 10, 1952. It has been little known in Southern Illinois.

Plethodon glutinosus glutinosus (Green): Ferne Clyffe, July, 1951; Cave Hill (Saline County), July 13, 1951; Kincaid Ridge, July 28, 1951, April 19, 1952; Herod, October 27, 1951; Alto Pass, April 22, 1952. Common on hillsides.

Eurycea bislineata bislineata (Green): Herod, October 27, 1951; Olmstead, March 10, 1952.

Eurycea longicauda longicauda (Green): La Rue, June 15, 1951; Kincaid Creek, June 28, 1951, April 19, 1952; Herod, July 1951; Pope County, July 13, 1951; Union County State Forest, September 15, 1951; Pine Hills, April 19, 1952.

Eurycea lucifuga Rafinesque: Ferne Clyffe, 1951; La Rue, June 21, 1951; Giant City Cave, July 29, 1951; Union County State Forest, September 15, 1951; Clear Spring Rock, April 19, 1952. The distribution of this salamander has been little known in Southern Illinois.

Necturus maculosus maculosus (Rafinesque): Crab Orchard Lake, May 1949; Cave-In-Rock, September, 1951.

Siren intermedia nettingi Goin: Boskey Dell, June 10, 1937; Crab Orchard Lake, May 4, 1951. Pine Hills Swamp, July 20, 1952.

LIZARDS

Leiolopisma laterale (Say): Natural Bridge Park, Pomona, July 12, 1951; Kincaid Ridge, September 2, 1951; Union County State Forest, September 15, 1951; Herod, October 20, 1951.

Eumeces fasciatus (Linnaeus): Cave Hill (Saline County), July 13, 1951; Union County State Forest, September 15, 1951; Herod, October 20, 1951; Horseshoe Lake Island, March 29, 1952; Crab Orchard, April 17, 1952.

Eumeces laticeps (Schneider): Pine Hills, May 1951; Union County State Forest, May 16, 1952.

Cnemidophorus sexlineatus (Linnaeus): Benson's Bluff, Goreville, May 30, 1933; Union County State Forest, May 12, 1951.

SNAKES

Diadophis punctatus strictogenys Cope: Union County State Forest, May 11, 1951.

Diadophis punctatus edwardsi (Merrem): Clear Spring Park, October 1950.

Storeria occipito-maculata (Storer): Kincaid Creek, June 28, 1951; Pine Hills, April 30, 1952.

Storeria dekayi (Holbrook): Carbondale, Field Trial Grounds, October 13, 1951; Buckner, April 21, 1952; Pine Hills, April 30, 1952.

Virginia valeriae elegans (Kennicott): Union County State Forest, September 15, 1951.

Carphophis amoena amoena (Say): Pine Hills, April 30, 1952.

Carphophis amoena helenae (Kennicott): Union County State Forest, October 1951.

TURTLES

Trionyx ferox spinifera (Le Sueur): Horseshoe Lake, April 24, 1952.

Terrapene ornata (Agassiz): Nashville (Washington County), May 14, 1952.—HILDA A. STEIN, Southern Illinois University, Carbondale.

A Rare Snake Anomaly

Accounts of "double monsters" and other such developmental freaks have appeared in zoological writings from very early times, apparently first in Aristotle's works. Reports of two-headed snakes, two-headed turtles, and other naturally-occurring duplication anomalies are found regularly in the literature of today. With respect to serpents, the latest and most comprehensive summary of such cases is that of Cunningham (1937, Axial bifurcation in serpents. Duke U. Press, Durham, N. C.).

The subject of this note, a newly-born Gulf Water Snake, *Natrix sipedon clarkii* (B. and G.), shows so rare a type of duplication that it appears worthy of record. Briefly, the specimen may be described as having a single head with two bodies, the latter irregularly fused along their anterior one-third (fig. 1). Cunningham (*lit. cit.*) refers to this type of anomaly as posterior dichotomy and reports only a single known example of it, a young *Vipera berus* Linn. described by Strohl (1925, Ann. Sci. Nat. Zool. 8:105-132). The rarity of this type when compared with other forms of duplication is well shown by the fact that Cunningham (*lit. cit.*) lists about 165 fully authenticated cases of cephalic and anterior dichotomy. A search of the literature following Cunningham's work reveals no other report of a two-bodied or two-tailed snake.

The present specimen (Univ. Ill. Mus. Nat. Hist. no. 26728) was born July 29, 1951, in company with ten normal snakes, one other dead at birth, and two undeveloped eggs. The parent had been captured twelve days previously on Deer Island, Mississippi Sound, near Biloxi, Mississippi. The deformed snake died shortly after birth, a few weak movements being the only signs of life.

The head is single but atypical. The snout is unusually narrow and the top of the head behind the eyes is raised abruptly to a bony knob which is covered by a single large "interparietal" plate. Except for minor variations in shape the other head plates are normal.

Behind the head the bodies are extensively fused, chiefly along their ventral surfaces, but the double nature throughout is evident in shape, scalation, and color pattern. For a short distance posterior to their point of separation each body is laterally compressed and bent upon itself with some areas of the venters apposed and fused. Only the posterior third of each twin appears normal.

Internally, most of the organs are double and appear to lie in a common cavity, although the exact coelomic boundaries were not determined.

The glottis in the floor of the mouth leads to an apparently normal lung lying in the right half of the fused double body. No rudimentary lung was seen here. On the left side is a similar lung with a completely separate trachea that opens by way of a "glottis" in the roof of the pharynx at about the level of the base of the skull. This second lung bears a rudimentary partner at its junction with the trachea, but which is right and which is left is not clear because of the distorted body axis in this region.

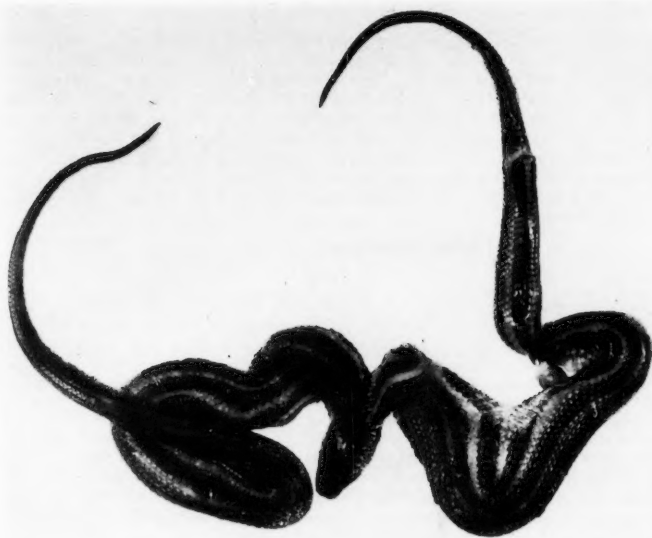


Fig. 1.—Anomalous newly born *Natrix sipedon clarkii* (fused anterior regions separated for X-raying)

There are two hearts, each completely separate and apparently functional.

The esophagus and stomach are single. Just below the stomach, however, the intestine receives two common bile ducts which enter on opposite sides. The liver, gall bladder, pancreas, and spleen are all double and separate. About one half of an inch behind the stomach the intestine becomes divided, each half leading to its own cloaca.

Normal sets of kidneys and gonads are present in each body. In both cases the right kidney and right gonad are somewhat anterior to the left ones (the usual arrangement in snakes), hence the bodies are not mirror images of each other. Both bodies are female.

An X-ray of the specimen reveals two vertebral columns, each completely separate, bearing a normal set of ribs, and articulating independently with the skull. The occipital region of the skull is somewhat expanded, but further details of these articulations are not clear. The presence of two complete and independent vertebral columns was also a feature of the *Vipera berus* described by Strohl (*lit. cit.*).—JAMES C. LIST, University of Illinois, and PHILIP W. SMITH, Illinois Natural History Survey, Urbana.

A New Nematode, *Chlamydooprocta itascensis* n. gen., n. sp., (Spiruridae) from a Skunk, *Mephitis mephitis*, in Minnesota*

In the stomach of a skunk, *Mephitis mephitis*, collected in Itasca State Park, Minnesota, about 20 spirurids were found attached to the mucosa. Examination showed that they do not belong to any of the known genera or species. A new genus, *Chlamydooprocta*, is erected for them, and the name *Chlamydooprocta itascensis* n. gen., n. sp., is proposed for the species.

* Joint contribution from the University of Minnesota Biological Station and Rice Institute.

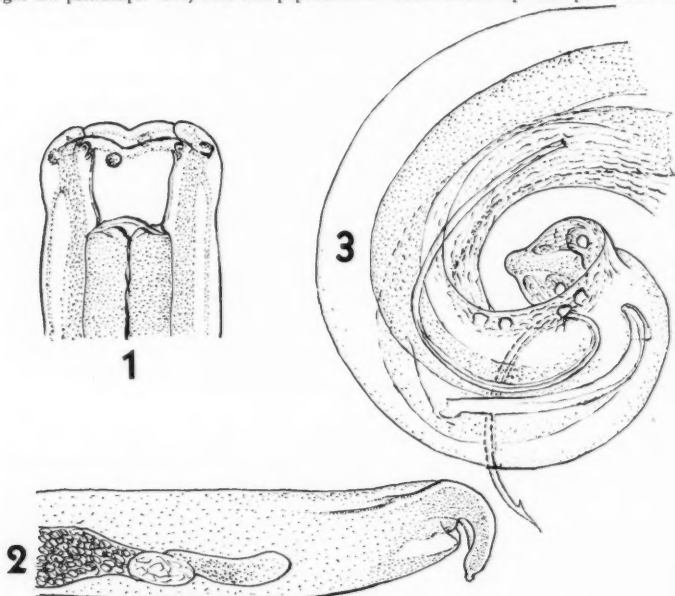
Chlamydopecta n. gen.

Diagnosis.—Small worms with finely striated cuticle, provided with narrow lateral flanges anteriorly. Oral cavity cylindrical, somewhat deeper than wide, approximately circular, slightly narrower posteriorly. Mouth opening surrounded by a thickened chitinous ring, with eight slightly elevated pseudolips. Four well-developed oral papillae. Esophagus long, cylindrical, not clearly divided into two portions. Male with tail spirally coiled, with well-developed lateral alae, and with 1 pair of postanal, 2 pairs of adanal and 2 pairs of preanal sessile papillae. Spicules unequal and dissimilar; gubernaculum present. Female with anus covered by a hood-like ventral process of the body, and body ending in a finger-like tail with a small tubercle at tip. Vulva near middle of body, the uteri amphidelphous. Eggs small, thin-shelled.

Chlamydopecta itascensis n. sp.

Figs. 1-3

Diagnosis.—FEMALE: Length 5 to 6 mm. with maximum width of 105 to 120 μ , maintained from anus to level of posterior end of esophagus, thence tapering to 48 to 52 μ across head region, and contracting abruptly to a tail about 60 μ long, curved ventrally, and appearing finger-like in lateral view, but with lateral flanges that make it taper gradually in dorsal or ventral view. Beginning about 50 μ anterior to roof of finger-like tail, ventral wall of body projects backward, hood-like, over anal region. Esophagus 1.1 to 1.2 mm. long, 50 to 53 μ in diameter at posterior end, and without distinct division into muscular and glandular parts. Excretory pore 225 to 230 μ from anterior end; nerve ring 160 to 180 μ from anterior end. Mouth capsule cylindrical, 34 to 38 μ deep and 18 to 20 μ in diameter at anterior end, narrowing slightly posteriorly; surrounded by thickened chitinous ring anteriorly, with a narrower ring just behind this. Anterior ring formed into eight low pseudolips. Only four oral papillae seen. Vulva an inconspicuous pore in middle



Figs. 1-3 *Chlamydopecta itascensis*.—1. head; 2. posterior end of female; 3. posterior end of male

of body. Anterior extremity of anterior uterus just anterior to posterior end of esophagus. Eggs small, elongate, rather thin-shelled, measuring 26 to 29 by 31 μ .

MALE: Length 3.5 to 4.8 mm. with maximum diameter of 78 to 93 μ , maintained throughout most of length of body, but tapering in esophageal region. Esophagus 1 to 1.12 mm. long. Excretory pore 220 to 225 μ , and nerve ring 155 to 170 μ , from anterior end. Tail 60 to 85 μ long, spirally coiled, with broad alae marked by broken longitudinal ridges. Only sessile papillae present; one pair postnatal, two pairs adanal, and two pairs preanal; the two adanal papillae of one side, and the two preanal papillae of one side, closely approximated to each other. Left spicule about 575 μ long and about 7.5 μ wide throughout its length, terminating in a fish-hook tip. Right spicule 225 to 260 μ long and 14 to 15 μ broad, with blunt tip. Gubernaculum present. Testis extends forward to near posterior end of esophagus. Junction of testis and sperm duct 1.6 to 1.7 mm. behind end of esophagus.

It is remarkable, in view of the large number of previous reports on parasites of skunks in North America, from Quebec to Minnesota in the North to Texas in the South, that a parasite as distinctive as this one should not previously have been discovered. Since the worms were firmly attached to the mucosa, which showed evidence of damage similar to that in *Physaloptera* infections, this is not a case of pseudoparasitism. It is possible, however, that the skunk is not the usual host.—ASA C. CHANDLER, Rice Institute, Houston, Texas.

Book Reviews

THE ACTINOMYCETES—THEIR NATURE, OCCURRENCE, ACTIVITIES AND IMPORTANCE. By Selman A. Waksman. Chronica Botanica Co., Waltham, Mass. 1950. xx+230 pp., 39 figs., 44 tables. \$5.00.

The actinomycetes have in general been neglected by both bacteriologists and mycologists until recent interest in antibiotics directed attention toward them. A book which assembles the salient points of accumulated knowledge of the group is hence especially useful at this time. The author made his first contribution to the knowledge of this group some 15 years before Fleming observed the antibiotic activity of *Penicillium notatum*. His extensive writings on the actinomycetes as important agents of decomposition of the soil and his discovery of streptomycin produced by one of their number causes this book to be received with interest before its covers are opened.

The first two chapters are concerned with a general description of the group as a whole and a detailed account of a few of the more important species. Thus it is in no way intended as a manual for identification of the entire group. The author then discusses the morphology and life cycle of actinomycetes followed by a chapter on variations and mutations. Metabolism and metabolic products are treated fairly extensively in three chapters, with emphasis on antagonistic substances. A chapter on distribution of actinomycetes in nature is followed by a very brief consideration of their role in decomposition of organic material in the soil. A chapter each on plant and animal diseases caused by actinomycetes and a brief summary conclude the text. There is an excellent 23-page bibliography at the end of the book and an appendix which lists several dozen media used for actinomycetes. The appendix may prove to be of relatively little value, since neither the specific uses of the media nor pertinent literature citations are included. The half-tone illustrations are unfortunately of uniformly poor quality.

The book succeeds in presenting an easily-read, well-balanced account of the actinomycetes. Because of the wide field that it covers and its brevity it is primarily of value for orientation and familiarization with the group as a whole. The research worker with special interest in the group will necessarily be disappointed with the brevity of treatment of his field of particular endeavor, although the bibliography will undoubtedly prove of value.—JOHN A. JUMP, University of Notre Dame, Notre Dame, Indiana.

THE ALGAE OF ILLINOIS. By Lewis Hanford Tiffany and Max Edwin Britton. University of Chicago Press, Chicago. 1952. xiv+407 pp., including 108 pls. (containing 1,186 figs.). \$10.

As might be expected in a state that contains many and diverse aquatic habitats, the algae of Illinois have attracted much attention. Most notable of the early workers was

Charles Atwood Kofoid, whose studies of the plankton of the Illinois River (1898-1910) were of great importance to phycology throughout the world. More recently the work of E. N. Transeau, S. Eddy, and L. H. Tiffany has been especially important in adding to our knowledge of the Illinois algae. A comprehensive bibliographical and geographical catalog was prepared by M. E. Britton in 1944, working under the direction of Professor Tiffany. At that time it was planned to supplement this *Catalog of Illinois Algae* with a more extensive taxonomic treatment, "to include descriptions, keys, illustrations, and habitat analysis." This plan has materialized in the present book. It is appropriately dedicated to Professor Tiffany's teacher, Edgar Nelson Transeau.

The introduction includes a brief survey of the geomorphology of Illinois, with special reference to hydrography. The authors point out that more than half the state originally was poorly drained flat grassland, supporting a rich algal flora, but that much of this land has been drained to make it suitable for farming, thereby significantly reducing the extent of aquatic habitats. Nevertheless, the diversity of habitats remains, promising rewards for the careful collector. The systematic account comprises descriptions of all groups. Keys are provided for the genera within a class, irrespective of order and family, and for the species within a genus. Nearly every species is illustrated by a clear line drawing. A tabulation made by the reviewer shows that 982 species, varieties, and forms, representing 185 genera, are treated. The Charophyceae are not included. More than one third of the genera (68) are represented by but one entity. The largest genus is *Oedogonium*, with 110 entities, followed by *Spirogyra* with 70. Referring to the *Catalog*, one can see that the intensity of algal collecting varies markedly from one part of Illinois to another. Published records are available for only 64 of the 102 counties, and only 10 of these are represented by more than 50 species, 4 by more than 100 species. The question may arise whether the present book is prematurely written in view of the large proportion of the state that is phycologically unexplored. However, the cosmopolitan distributional patterns of the fresh-water algae make it improbable that a more extensive, but no more intensive, survey would add significantly to the flora. Rather, more intensive collecting even in relatively well-sampled areas is desirable, with emphasis on less usual habitats, such as soil and polluted waters. The number of Volvocales is likely to be markedly increased as the investigation of polluted waters proceeds. It is unlikely that *Chlamydomonas*, a genus in which more than 200 species have been described, is represented in Illinois by one species. *The Algae of Illinois* should serve as a useful point of departure for future studies in this region.

The printing is exceptionally fine, with large clear type. A minimum of typographical errors has been noted. The binding, of green cloth with gold lettering on the spine, seems of average durability. The price seems high, even considering the present cost of publishing.

Since the publication of Britton's *Catalog*, seven genera have been added to the known flora. These include *Chlamydomonas*, *Phacotus* and *Wislouchiella* (thereby adding the family Phacotaceae), *Hormidium* (due in part to a reinterpretation of previously recorded species of *Stichococcus*), *Binuclearia*, *Protosiphon* (thereby adding the family Protosiphonaceae), and *Porphyrosiphon*. Several taxonomic and nomenclatural changes are evident, which were foreshadowed in the second edition of Smith's *Fresh-water Algae of the United States*. Taxonomic changes include removing *Golenkinia* from the Chlorococcaceae and *Micractinium* from the Scenedesmeaceae and placing them in the Micractiniaceae; removing *Schroederia* from the Oocystaceae to the Characiaceae; and removing *Vaucheria* (and the family Vaucheriaceae) from the Siphonales in the Chlorophyceae to the Heterosiphonales in the Xanthophyceae, necessitating the adoption in the Siphonales of the family Dichotomosiphonaceae to receive the residual *Dichotomosiphon*, hitherto placed in the Vaucheriaceae. Nomenclatural changes include the use of *Haematococcus* in place of *Sphaerella*.

The carefully planned format is conducive to utility. The most obvious deficiency of the book is the lack of any bibliographical, geographical, or ecological data. Although the purpose of *The Algae of Illinois* as a supplement to the *Catalog* is fully recognized, the fact remains that its usefulness is seriously impaired by this arrangement. While a complete integration of the two types of information might have resulted in a volume of decreased utility by virtue of its bulkiness, still the book would be more useful if at least a phrase or two had been added to indicate the general habitat of a species and whether it is common or known from only one or two records. There is a lack of authenticity that will perhaps bother the researcher. The authors state that they have seen many of the

species in their own collections or in those of other phycologists; the validity of other records were judged on the basis of descriptions, figures, and herbarium specimens. It would be valuable to know exactly on what basis a species was admitted to the Illinois flora. *Chlamydomonas* and *Phacotus*, which were not included in the *Catalog*, are not supported by any collection data; I infer that they are recent discoveries of the authors. The illustrations, though informative, cannot be considered authentic as far as the algae of Illinois are concerned, inasmuch as most of them are redrawings from authors who were not depicting local forms.

That *The Algae of Illinois* will prove useful has been shown by experience during the first week of ownership, in which the majority of algae contained in certain lake samples from western Illinois were determined with ease. The authors and publishers are to be congratulated on producing a volume of such consistently high quality.—PAUL C. SILVA, University of Illinois, Urbana.

FLORA OF IDAHO. By R. J. Davis. Wm. C. Brown Co., Dubuque, Iowa. 1952. iv+828 pp. Photo-offset. \$7.50.

This book is the first manual of the flora of Idaho. It is based largely on botanical collections and field studies made by Dr. Davis, Professor of Botany at Idaho State College, Pocatello, and upon Idaho herbarium specimens in several of the more important herbaria in eastern United States. The author generously acknowledges assistance from a number of botanists, including several taxonomic specialists in certain groups of plants. There is a chapter on plant geography of Idaho, by R. F. Daubenmire, containing an account of the physiography, zones of vegetation, and a discussion of the origins of the flora. Discussion of the significance of zonation is descriptive and is based on indicator species. No underlying theory is expressed, and the use of the well known terms Hudsonian, Canadian, Upper Sonoran, etc., has been avoided, although they crop up here and there in the descriptive text. Under the heading of Origin of the Flora there is a thumbnail sketch of geological background, and a discussion of the present occurrence of certain species of plants.

As usual in botanical manuals the text consists of keys and brief descriptions of families, genera, and species. The habitats of each species are mentioned, followed by a general statement of total geographical range. No attention is given to orders or other higher taxa, although in the family key Pteridophyta and Spermatophyta are erroneously called phyla. The author presents no statistical summary of the contents of his book, but a hasty count indicates that there are approximately 2500 species in about 640 genera included in 102 families, as well as many varieties or other subspecific items. The sequence of families is that of the well known Englerian scheme, although genera and species are arranged alphabetically. The dichotomous keys are of the usual indented kind, and appear to be well constructed and practical.

The taxonomy of species seems on the whole to be rather conservative. Some of the species consist probably of two or more entities that many, if not most, contemporary or recent taxonomists have treated as distinct taxa, as, for example, the Idaho species of water-plantain is given the name of the European plant, *Alisma plantago-aquatica*; the western *Smilacina amplexicaulis* is called *S. racemosa*; *Veratrum eschscholtzii* is said to be conspecific with the eastern American *V. viride*, and *V. caudatum* with *V. californicum*; the quite distinct *Amelanchier cusickii* is merged with *A. alnifolia*; the western chokecherry, *Prunus melanocarpa* goes under the name of *Prunus virginiana* var. *demissa* of the Pacific Slope; *Rosa nutkana* is a coastal species, well separated geographically and morphologically from *R. spaldingii*; *Rudbeckia ampla* is submerged under *R. laciniata*, and all the cockleburs (except *X. spinosum*) are lumped as *Xanthium strumarium*.

That perennial *casus belli* of vascular plant taxonomists, namely, to capitalize or not to capitalize the initial letter of certain specific names, has evidently been the source of some little trouble here and there, because the author and some of his contributors have not always seen eye to eye in this matter. One may wonder why the var. *harneyense* of *Delphinium diversifolium* should have a capital H, or why *sitchensis*, the only species of *Romanzoffia*, should begin with a capital S, but perhaps these are merely typographical errors. Of course this is a very trivial subject anyway, but it would appear to this reviewer that in the second half of the twentieth century the most practical procedure is that of uniform decapitalization of names of all species.

Although, as already noted, the taxonomy of the book is generally conservative and

well balanced, there are, inevitably, in a work of this scope and size a few aberrations here and there, as for example: the attempt to maintain two species of *Equisetum*, as *E. kansanum*, and *E. laevigatum*; the only Idaho juniper as a variety of *Juniperus communis*; the placing of western hemlock and mountain hemlock in the same genus, *Tsuga*. *Ericaceae sensu lato* is divided into Pyrolaceae, Monotropaceae, and Ericaceae, *sensu stricto*, yet in the treatment of Gentianaceae, *Menyanthes* is included in that family. One wonders whether the European mint, *Mentha arvensis*, really occurs "over most of temperate North America," or whether the plant in question is the indigenous *M. canadensis*. It is almost certain that *Rosa pisocarpa*, a distinctive species of the Pacific Slope, does not grow spontaneously in Idaho. The name *Myriophyllum exalbescens* may be referred to *M. spicatum*.

In the Glossary, the definition of cell as a "cavity, of an anther or ovary" seems somewhat archaic, when actually a cell is the unit of structure of plants (and animals) whose essential feature is its living protoplasm.

Throughout the book there is abundant evidence of the author's thorough field knowledge of the flora of Idaho. An example of this is shown in the recognition of the western snowberry, *Symphoricarpos rivularis* Suksd., as a species distinct from *S. albus*, which does not extend as far west as Idaho, and there are numerous other examples of Dr. Davis' independence of the sometimes somewhat stereotyped treatments occasionally found in influential manuals dealing with the flora of eastern United States.

This is an authoritative pioneer monograph of the flora of Idaho, specially designed for the use of the student of botany as well as the general public. It will be indispensable for all who require accurate information concerning the identity of vascular plants of this region. Dr. Davis is to be congratulated on having produced such an informative and useful work.—GEORGE NEVILLE JONES, University of Illinois, Urbana.

STAGES IN THE EVOLUTION OF PLANT SPECIES. By Jens Clausen, Cornell University Press, 1951. viii+206 pp., 76 figs. \$3.75.

For more than thirty years, Dr. Clausen and his associates have carried on experimental studies in plant evolution by means of cytological and genetic analysis, and especially by growing plants in experimental gardens located at sea level, mid-altitude, and alpine stations. Plants used have been drawn principally from the genera *Achillea*, *Hemizonia*, *Layia*, *Madia*, *Potentilla*, and *Viola*. The present volume summarizes the results of their studies, the breadth of which can be seen from the chapter titles: The Evolution of Our Concepts of Speciation; The Local Population as the Basic Evolutionary Unit; The Evolution of Ecological Races; The Genetic Systems of Ecological Races and Morphological Subspecies; The Evolution of Interspecific Barriers; The Evolution of Groups of Species; and The Physiologic-genetic Species Concept and the Dynamics of the Evolution of Species and Genera.

Transplantation to the experimental gardens has done much to establish the nature of ecological races, which Clausen regards as more important for evolution than the morphological subspecies. By means of experimental crosses, it is demonstrated that the morphological differences between subspecies depend upon multiple factors, and the investigators believe that this is also true of the physiological races, but this is not proven. The role of selection is also assessed, and found largely responsible for the fact of adaptation.

On the whole, the picture which emerges is one of neo-Darwinian evolution. A wealth of observational and experimental detail is presented at every stage. This is a very valuable book, a "must" for everyone interested in evolution.—EDWARD O. DODSON, University of Notre Dame, Notre Dame, Indiana.

MICROCLIMATES AND MACROCLIMATES OF NEOTOMA, A SMALL VALLEY IN CENTRAL OHIO. By John N. Wolfe, Richard T. Wareham, Herbert T. Scofield. Ohio Biological Bulletin 41 (Vol. 8, No. 1). 1949. viii+267 pp., 85 tables, 100 figs., of which 36 are photographs. \$1.50.

To anyone interested in topographic pattern of vegetation and its interpretation this report should prove both instructive and stimulating. It presents in fine fashion the adventures of a research team in their attempt to measure and describe the effective environmental variation in a local area in relation to species behavior and distribution and to vegetation pattern. It comprises a series of related investigations of major importance

representing a five-year field program. The results of these investigations are presented in commendable detail yet with the forbearance required by limitations of space and digestibility. Obviously one of the most difficult jobs has been the selection of only representative and apparently significant portions of the basic data.

The setting, a mile-long valley called Neotoma because it was the first reported station for the Allegheny woodrat in Ohio, had, even prior to the investigation here reported, received more biological attention than any area of comparable size in the state of Ohio, and was a particularly appropriate site because of the obviously great range of specific habitats present in an area of no more than 125 acres. It lies in Hocking County at the western border of the Appalachian Plateau, which also approximates the maximum extent of Pleistocene ice toward the southeast, and is characterized by a total relief of about 300 feet, a partial rim of cliffs up to 50 feet high and a tight cove with waterfall at its head. Its remnant vegetation includes the entire range from the pioneer lichen communities and small assemblages of dry prairie species on the cliffs to mixed mesophytic forest which includes hemlock and sweet birch and to a buttonbush-alder seepage swamp.

In the course of more than 300 trips to the valley, between 100 and 300 instruments were read and reset each week-end, and data and field observations on the environment and vegetation were recorded. Principal emphasis in these investigations may be inferred from space allotment in the report. Out of a total of 275 pages, 50 are devoted to microclimatic variation in air temperature, with principal emphasis on the "seedling level"; 12 to light; 21 to atmospheric moisture including precipitation, evaporation and humidity; 10 to soil and litter temperatures; 11 to the description of specific habitat climates ("phytomicroclimates"?); 40 to phenology and related interpretation of the seasons; 43 to interpretation of "macroclimatic" data from the Lancaster station, some 9 miles distant. The 88 pages not accounted for in this breakdown consist of regional setting and climatological background as well as summary, appendix, and bibliography, and integrate the report as an independent teaching reference.

The most prominent thesis of the report is to call attention to and document the differences among the specific habitat climates of herbaceous plants and the seedling stages of woody plants in this region of diverse topography, and to stress the differences between these microclimates and the climatic generalizations based on the data of the nearest official Weather Bureau Station, nine miles away in Lancaster. But how much of the difference is due to geographic separation and how much to the mode and level of exposure of the instruments? It is obvious in retrospect that a standard Weather Bureau installation in the study area itself would have yielded valuable comparative data.

The microclimates of certain individual species received special attention with reference to season of vegetative activity as well as location, and the environmental temperature (of individuals?) of selected species is presented diagrammatically: *Claytonia virginica*, *Silene rotundifolia*, *Hepatica triloba* (*H. americana*), *Asclepias quadrifolia*, and *Dicentra canadensis*.

It is hoped that climatic emphasis in the title will not divert too much of the broader potential audience from the fine description and interpretation of the deciduous forest included in the "phenological calendar for 1941-1942" (pp. 210-238), "the seasons in the Hocking Hills" (pp. 66-76) and "the microclimates of individual species" referred to in the preceding paragraph (pp. 199-209). The literary style of the phenological calendar is particularly delightful, and its imagery characterizes the seasonal changes in the deciduous forest and its inseparable environment in a way which has not previously been done.

This project has played a prominent part in the first real resurgence of interest in the measurement of effective environment since the atometry of the twenties and early thirties. It may well be that its contribution as a stimulus to further investigation will even exceed its own important direct contribution to our understanding of local environmental variation and its biological significance.—ROYAL E. SHANKS, University of Tennessee, Knoxville.

VIVARIUM LIFE, A MANUAL ON AMPHIBIAN REPTILES AND COLD-WATER FISH. By Alfred Leutscher. Cleaver-Hume Press Ltd., London. 1952. 230 pages, illustrated. \$2.00.

It is appropriate that the secretary of the British Herpetological Society should write a book devoted mainly to the keeping of amphibians and reptiles in captivity, with additional chapters on fishes and pond life, for the keepers of aquaria and terraria must make

up a large proportion of the society. The book is a useful one for the beginner in this hobby, which in the United States is much less developed than in Europe. Its directions for keeping frogs and salamanders and lizards, snakes and other reptiles are thoroughly practical. Unfortunately, the illustrations leave much to be desired and cannot compare with the good photographs now available for the European cold-blooded vertebrates.

The book fails also to give the reader or user any introduction to the fascinating study of animal behavior, in which the older natural history is made more exact and converted into a science by more critical and more repeated observation. With the fine book by Malcom Smith on the amphibians and reptiles of Britain now available, a child might well begin with Leutscher and graduate at an appropriate age to Malcolm Smith.—KARL P. SCHMIDT, Chicago Natural History Museum, Chicago.

I DRANK THE ZAMBEZI. By Arthur Loveridge. Harper and Brothers, New York. 1953. xiv+296 pp., illustrated. \$4.00.

Mr. Loveridge's third book of African travel recounts the trials and tribulations, both petty and serious, and the very considerable successes of his last collecting trip to the great dark continent. Arthur Loveridge began his contributions to the knowledge of African reptiles in 1918. He went out to the Natural History Museum in Nairobi in 1914, served during World War I in the East African Mounted Rifles, and was later a game warden in Tanganyika Territory. In 1924 he came to the United States to take charge of the reptile collection of the Museum of Comparative Zoology at Harvard. Subsequent successive expeditions to various parts of east Africa, all in the interest of the collections of the museum, have given him a commanding knowledge of the African fauna and of its geography. His observations on any part of Africa are thus weighted by nearly forty years of experience and study. Add to this the author's meticulous honesty in reporting, and all three books are evidently essential to the naturalist's bookshelf.

The present book is the rewritten diary of an expedition to Nyasaland primarily to obtain specimens of amphibians and reptiles, but with mammals a close second in interest, and other creatures less collected only for lack of time and gear. The author was accompanied by his wife and sister-in-law. The book suffers perhaps from the fact that Arthur Loveridge is far too competent and conscientious a traveller to have adventures. There results a pedestrian style in which trivia are indistinguishable from more important events. One might wish that the author had given us more of his notes on the habits of animals and less of the incidents of camp life. Most museum zoologists of my generation envy him the opportunity to travel with his wife and envy the luxury of travel in a new truck provided with the competent driver his sister-in-law turned out to be. The account of the journey to the remnants of mountain forests in this corner of Africa, which are rapidly disappearing and bearing to extinction their associated animal life, affords an unhappy glimpse of the African phase of the world problem of soil erosion.

Mr. Loveridge's prejudice in favor of white rule in Africa brings him too close, for the sympathy of many readers, to doctrines of racial superiority in general. I fear he would be horrified by the considered observation of Thorstein Veblen that quite as man is the most destructive of animals, the white race is alike the most predatory and the most destructive of the human groups.

The book is somewhat misnamed, for it is mainly about Nyasaland and deals only cursorily with the Zambezi region. One wishes that there had been a little more of the background of exploration of this part of the world, and especially about its zoological pioneer, W. C. H. Peters, whose *Reise nach Mossambique* extended from 1842 to 1848.

Mammalogists and herpetologists will wish to index the material in their fields in *I Drank the Zambezi*, and this will be facilitated by the insertion of the scientific names in the text and their appearance in the index.—KARL P. SCHMIDT, Chicago Natural History Museum, Chicago.

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